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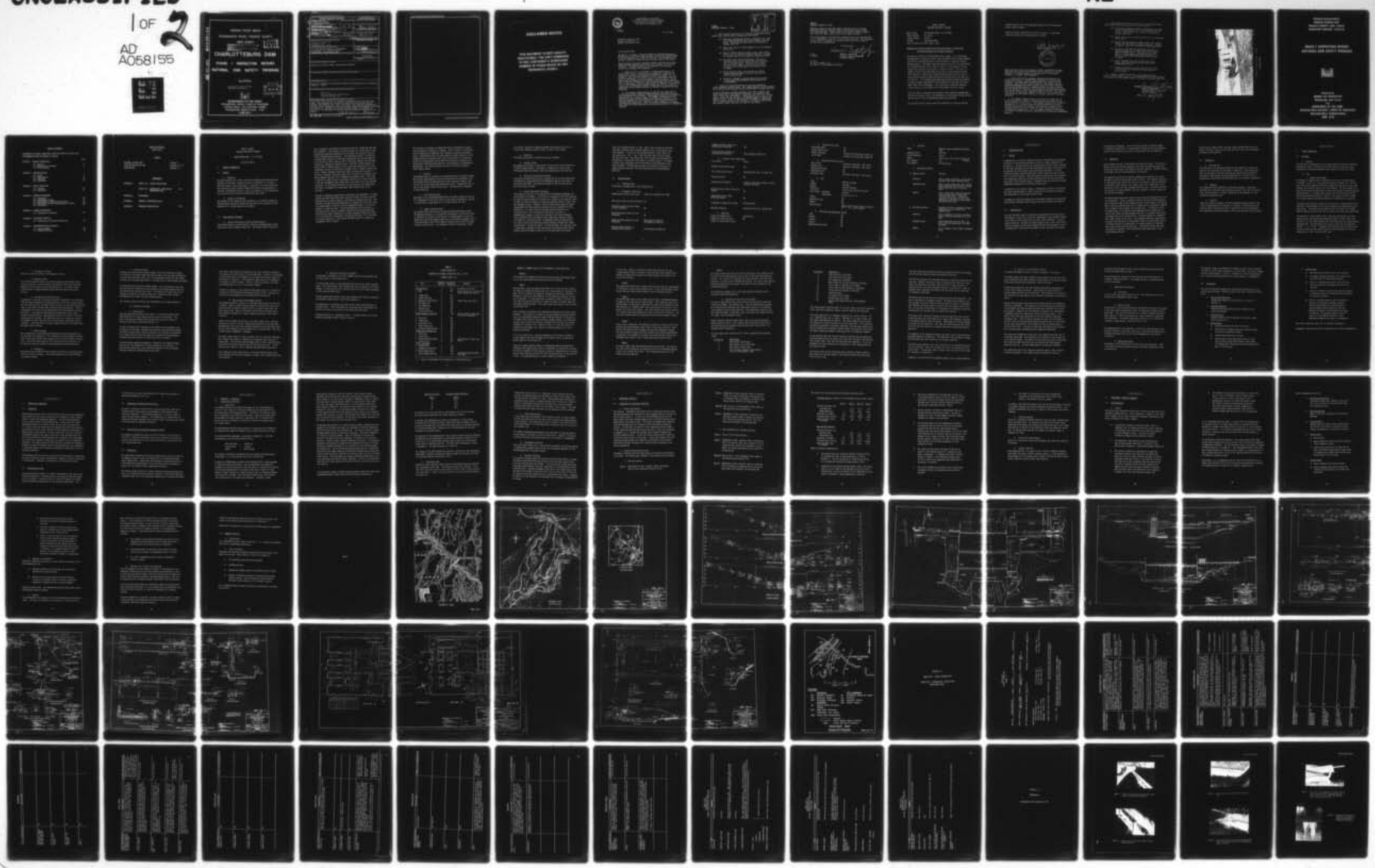

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PASSAIC RIVER BASIN

PEQUANNOCK RIVER, PASSAIC COUNTY

NEW JERSEY

LEVEL II

CHARLOTTEBURG DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NJ00316

Approved for public release;
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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE - 2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106
JUNE 1978

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National Dam Safety Program Phase I
Charlotteburg Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

31 JUL 1978

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Charlotteburg Dam in Passaic County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given on the first three pages of the report.

Based on visual inspection, available records, calculations and past operational performance, Charlotteburg Dam is judged to be in good condition. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. Modification of the automatic operating mechanism for the large bascule gate at the dam's crest is essential to preclude the possibility of sudden, high downstream flows due to failure of the mechanism. When the dam's reservoir is full, this sudden, high flow would be approximately 85 percent greater than 1903 flood of record. Modification planning should be completed within six months from the date of approval of this report and the modification implemented within the next six months. Until the modification is completed, the reservoir level should be immediately lowered to elevation 741.2 to negate the consequences of any possible failure of the gate's automatic operating mechanism.

b. An automatic warning system, in case the gate lowers due to an operating failure, should be installed within six months from the date of approval of this report. The automatic warning system should be comprised of, as a minimum, visual and audible alarms for both the dam and downstream water treatment plant operators, together with an automatic warning tie line to police and civil defense officials in the downstream communities. Until the automatic system is operational, other means of quickly warning all concerned parties should be immediately employed.

NAPEN-D
Honorable Brendan T. Byrne

c. The following corrective actions should be undertaken within twelve months from the date of approval of this report.

(1) Investigate through dam leakage in horizontal lift joint in non-overflow monolith No. 11 and formulate plan for repair. Repair of this joint should be initiated in calendar year 1979.

(2) Repair lift joint in overflow monolith No. 9 at elevation 685 to 690 $\pm$.

(3) Dewater stilling basin and inspect floor, chute blocks and end sill for erosion of concrete surfaces. Repairs, if required, should be initiated in calendar year 1979.

(4) The bascule gate should be repainted. The gate's operating piston rod seal should repacked to prevent loss of hydraulic fluid. The scales on the right side of the gate should be checked and repaired to eliminate large volume leakage water when the gate is closed.

(5) Repair automatic pool level recorder and restore plugged sump pump leading from cone valve pit in Intake and Gate House.

(6) Initiate a program to control brush and tree growth in the channel area immediately downstream of the stilling basin.

d. Studies to verify the adequacy of the dam's foundation design parameters should be made. Any remedial measures found necessary, as a results of these studies, should be initiated in calendar year 1979.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Robert A. Roe of the Eighth District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, thirty days after the date of this letter.

NAPEN-D
Honorable Brendan T. Byrne

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia, 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely yours,

Harry V Dutchyshyn

HARRY V. DUTCHYSHYN
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Cy furn:
Mr. Dirk C. Hofman, P.E.
Department of Environmental Protection

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Charlotteburg Dam, I.D. NJ 00316
State Located: New Jersey
County Located: Passaic
Stream: Pequannock River
Date of Inspection: May 1 and 6, 1978

Assessment of General Condition of Dam with respect to Safety and Recommended Action with Degree of Urgency

The general condition of Charlotteburg Dam is good. It is maintained and operated in conjunction with a water treatment facility approximately one half mile downstream, and is visited daily by a competent and experienced staff. The major condition requiring action is the possibility of increased spillway flow in case of failure of the hydraulic piping operating the automatic crest gate, of bascule design. This gate, if suddenly lowered could discharge stream flows of approximately 10,000 cubic feet per second which is significantly higher than the flood of record which occurred in 1903 and had an estimated flow at the dam site of 5,850 cfs. The automatic gate operating mechanism should be modified to prevent sudden and possible violent openings of the gate with consequent large stream discharges. Plan formulation should be completed within 6 months and the modification implemented within 12 months.

Until the gate is modified, the reservoir level should be lowered immediately to elevation 741.2, corresponding to a discharge of 4,000 cfs over the spillway in case of hypotherical gate piping failure.

Au automatic warning system should be installed for the plant and dam

operating staff and to the downstream communities of Kinnelon and Butler within 6 months.

Other actionable conditions are listed in Section 7.1 and these conditions should be corrected within 12 months.

Robert Gershowitz, P.E.

Robert Gershowitz, P.E.

STATE OF NEW JERSEY
ROBERT GERSHOWITZ
20812
LICENSED
PROFESSIONAL ENGINEER

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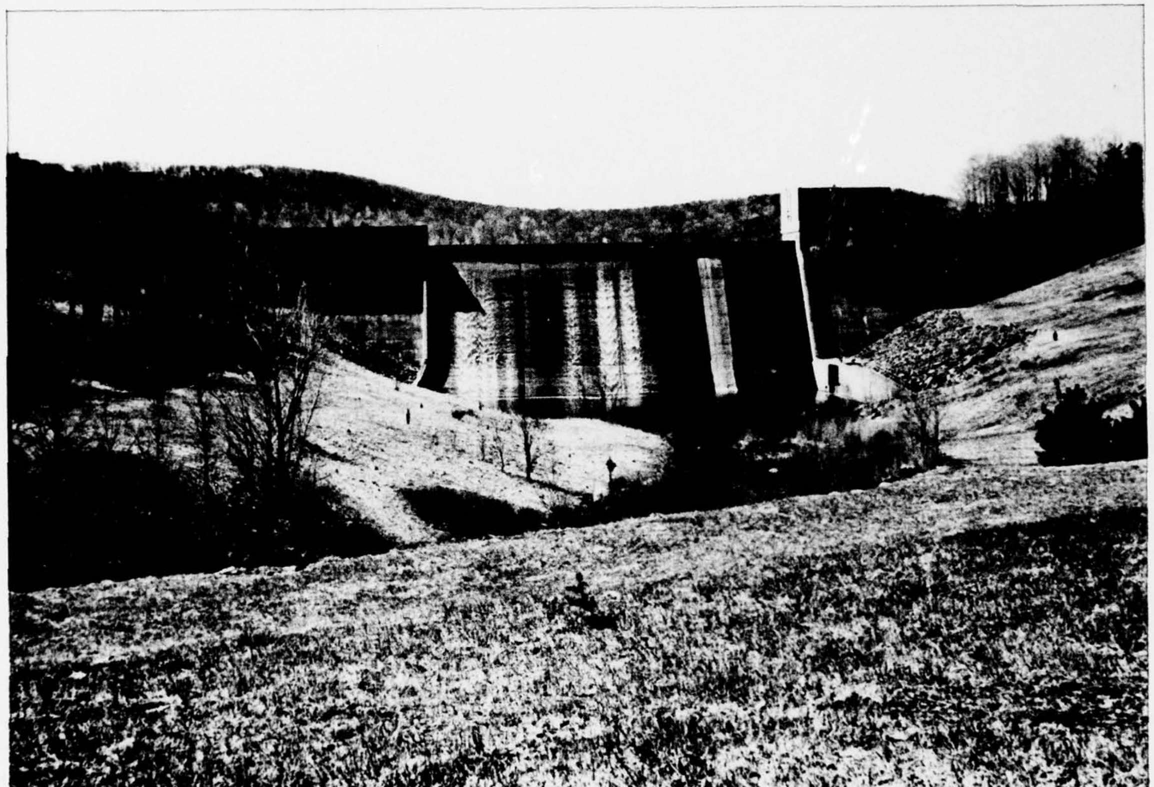
APPROVED: Harry V Dutchyshyn
HARRY V. DUTCHYSHYN
Colonel, Corps of Engineers
District Engineer

DATE: 31 July 1978



May 1978

C H A R L O T T E B U R G   D A M

OVERVIEW PHOTO

PASSAIC RIVER BASIN
CHARLOTTEBURG DAM
PASSAIC COUNTY, NEW JERSEY
INVENTORY NUMBER: NJ00316

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by
HARRIS-ECI ASSOCIATES
Woodbridge, New Jersey
for
DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA
JUNE 1978

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NATIONAL DAM SAFETY PROGRAM

CHARLOTTEBURG DAM, I.D. NJ 00316

SECTION 1

1. PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August 1972 authorizes the Secretary of the Army, through the Corps of Engineers to initiate a national program of dam inspections. Inspections for Charlotteburg Dam were carried out under Contract DACW61-78-C-0100 to the Department of the Army, Philadelphia District, Corps of Engineers, by the engineering firm of Harris-ECI Associates of Woodbridge, New Jersey.

b. Purpose of Inspection

The purpose of the inspection and evaluation is to identify conditions which threaten the public safety and thus permit the correction of the conditions in a timely manner by the owners.

1.2 Description of Project

a. General Description of Dam and Appurtenances

Charlotteburg Dam is a concrete gravity dam with a maximum height of 102 feet and an overall length of 675 feet. The central 200-ft long spill-

way is flanked by two gravity non-overflow sections, termed the east and west bulkheads. The spillway is gated by means of a single 200-ft long bascule gate operated automatically to maintain the reservoir level at certain predetermined elevations. The downstream channel is protected from the high velocities of the water discharging over the spillway by a stilling basin 200-ft wide by 107-ft long which reduces the discharge velocity by creating an hydraulic jump. Low level outlet features include a 48-in. diameter bypass line at centerline elevation 677.0 that discharges into the stilling basin through a 30-in. diameter hollow cone valve. Normal treatment plant water needs are drawn off by means of two 48-in. diameter lines that unite into a single 54-in. diameter line which conducts the water to a treatment and aeration plant. The inlet to the 48-in. bypass and 54-in. raw waterline consists of a trash rack and a stop log arrangement that allows water to be drawn off at any desired elevation. At the inspection date, the stop logs and its spaced aperture were so arranged as to draw water from elevation 725 in the reservoir.

The dam is founded on sound granite and gneiss rock formations. A grout curtain has been established and a system of drains has been installed downstream of the grout curtain drilled from a foundation gallery. The reservoir created by Charlotteburg Dam is U shaped and covers 350 acres. Its maximum depth is 80 feet, and the impounded volume is 2.9 billion gallons or 8,950 acre feet. At the upstream end of the reservoir, a concrete gravity river wall 2,050-ft long by 26-ft maximum height has been built to avoid inundation of railroad trackage originally belonging to the New York, Susquehanna and Western Railroad. This structure has been designated as a New Jersey Dam 00547 which will require an independent Phase I Report.

The reservoir rim slopes are generally mildly to moderately sloping with no apparent sloughing or slumping. The soil cover is relatively shallow underlain by competent rock formations covered by deciduous trees. Charlotteburg Dam lies downstream of another reservoir on the Pequannock River, Oak Ridge and is also fed by waters of Clinton Reservoir on Clinton Brook and by Canistler Reservoir on Pacock Brook. Downstream of Charlotteburg Reservoir, the Pequannock is impounded at Macopin Dam. All these reservoirs are part of the City of Newark Water Supply System.

b. Location

Charlotteburg Dam is located on the Pequannock River in Passaic County, New Jersey, approximately 12 miles upstream from its confluence with the Pompton River and approximately 6 miles upstream of Butler, New Jersey, the nearest downstream population center. Pequannock River is part of the greater Passaic River Basin. The reservoir is adjacent to State Route 23.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection" by the U.S. Department of the Army, Office of the Chief of Engineers, the dam is classified as Large based as its height exceeds 100 feet.

d. Hazard Classification

The dam has been classified as having High Hazard Potential by the Philadelphia District, U.S. Army Corps of Engineers, on the basis that in the event of failure of the dam and its appurtenances or its misoperation, significant damage could occur to the water treatment facilities belonging to the City of Newark located within a half mile downstream of the dam site. The community of Butler, New Jersey, would

also suffer significant community damages and possible high loss of life by the released reservoir waters in case of dam failure.

e. Ownership

The dam and reservoir are owned by the City of Newark.

f. Purpose of Dam

The purpose of the dam is store water for use by the City of Newark in its Water Supply System. The water is treated in an aeration and chlorination facility within a half mile downstream of the dam site.

g. Design and Construction History

The dam was designed for the City of Newark by the private engineering firmofParsons, Brinkerhoff,Hall,and MacDonald, New York, New York, in the period 1957-1958. Construction started in 1959 and the dam was put into service in 1961.

h. Normal Operational Procedure

The purpose of the dam is to store water for subsequent treatment and use by the City of Newark. On the day of inspection, 82 million gallons per day were being drawn off for this use. Normally, the reservoir level is kept at a level designed to capture the maximum volume of water from the Pequannock River. Normally, the 5-ft high bascule gates are kept closed above the fixed concrete spillway crest at elevation of 738.0 above M.S.L., so that the top of the bascule gate extends up to elevation 743.0. With increasing flood waters, the gate is automatically lowered, so that the reservoir level remains between 743.5 and 744.0 until discharges reach 11,000 cubic feet per second. At 11,000 cfs, the bascule gate is completely lowered automatically, and rests on the fixed concrete spillway forming a smooth ogee shaped crest profile. During the summer low flow periods, the reservoir level is drawn down according to the water needs of the Newark Water Supply System, and can be down as much as 8 to 10 feet below top of gate

level for extended periods of time. Water level records are recorded and kept; currently being recorded manually from a staff gage on the left abutment. A review of the recorded reservoir water levels for the sample year 1971, show that the water level did not exceed 743.30 at any time. The sample year 1971 included the extratropical storm Doria, a significant storm event in Passaic County. The amount of water being discharged over the spillway at Charlotteburg is not being recorded. Stream gaging records are available at the U.S.G.S. gage at Macopin Dam some 1.3 miles downstream of the Charlotteburg Reservoir.

1.3 Pertinent Data

a. Drainage Areas

At dam axis, drainage area is 56.3 square miles.

b. Discharge at Dam Site

Maximum known flood at dam site:	5,850 cfs on October 10, 1903.
Warm water outlet at pool elevation:	NA
Diversion tunnel low pool outlet at pool elevation:	NA
Diversion tunnel outlet at pool elevation:	NA
Gated spillway capacity at pool elevation:	743; capacity 5,600 cfs 744; capacity 11,000 cfs
Gated spillway capacity at maximum pool elevation:	747.2; capacity 20,500 cfs

Ungated spillway capacity at maximum pool elevation:	NA
Total spillway capacity at maximum pool elevation:	747.2; capacity 20,500 cfs

c. Elevation (feet above MSL)

Top of Dam:	750.0
Maximum flood control pool:	NA
Full flood control pool:	Elevation 743 (elev. of gate lip)
Recreation pool:	NA
Spillway crest (gated):	Elevation 738 (bascule gate in fully lowered position)
Upstream portal invert diversion tunnel:	NA
Downstream portal invert diversion tunnel:	NA
Streambed at centerline of dam:	Elevation $667^{\pm}$
Maximum tailwater:	Elevation $675.5^{\pm}$ (Q = 20,500 cfs)

d. Reservoir

Length of maximum pool:	12,730 feet
Length of recreation pool:	NA
Length of flood control pool:	

e. Storage (acre-feet)

Recreation pool:	NA
Flood control pool:	NA
Design surcharge:	Elevation 747;(storage 10,400 AF)
Top of dam:	Elevation 750;(storage 11,500 AF)

f. Reservoir Surface (acres)

Top of Dam:	Elevation 750;(area = 575 acres)
Maximum pool:	Elevation 748;(area = 450 acres)
Flood-control pool:	NA
Recreation pool:	NA
Spillway crest:	Elevation 738 (area = 312 acres)

g. Dam

Type:	Gravity concrete
Length:	675 feet
Height:	102 feet maximum
Top width:	15 feet (non-overflow section)
Side slopes - Upstream:	vertical
- Downstream:	0.775 H on 1.0 V
Zoning:	NA
Impervious core:	NA
Cutoff:	NA
Grout curtain:	Grout curtain from Inspection Gallery @ 5'-6' o/c; depth unknown

h. Diversion and Regulating Tunnel

Type:	NA
Length:	NA
Closure:	NA
Access:	NA
Regulating Facilities	NA

i. Spillway

Type:	Concrete ogee surmounted by bascule gate
Length of weir:	200 feet
Crest elevation:	738.0
Gates:	200-ft long x 5-ft wide, single leaf bascule
U.S. Channel:	NA
D/S Channel:	Stilling basin

j. Regulating Outlets

• Bypass Outlet:	48-inch
Controls:	48-in. square slide-gate, electrically operated from floor elevation 750.5
Emergency gate:	48-in. square Broome gate with lifting beam placed with aid of crane located above operating floor, elevation 750.5
Outlet:	30 in. hollow cone valve discharging into stilling basin through left stilling basin wall; centerline elevation of the pipe is 677 at the upstream end and 675.5 at the discharing hollow cone valve
• Raw Water Conduit:	Diameter twin 48-in. diameter passages converging into a single 54-in. diameter pipe
Controls:	30-in. diameter cone valve and 48-in. square slide gate on each 48-in. dia. pass
Emergency gate:	Same Broome gate used for 48-in. by-pass line (One Broome gate for three passages)
Outlet:	54-in. diameter line to water treatment plant

SECTION 2

2. ENGINEERING DATA

2.1 Design

A complete set of as-built drawings exists for Charlotteburg Dam showing in detail all the pertinent features on which a safety evaluation can be based on. The only feature not clearly shown on the as-built drawings is the final configuration of the consolidation grouting at the base of the dam and the grout curtain drilling pattern and depth. A visual inspection gallery revealed that grout curtain holes have been drilled at a 5 to 6-foot spacing. The grout curtain combined with the competent rock formations underlying it have effectively cut off the head water, since very little drainage water is emanating from the drain hole system immediately downstream of the grout curtain holes.

In addition to the contract plans, a "Memorandum of Design of Charlotteburg Dam" dated December 3, 1957, exists and is available, describing the derivation of the spillway design flood.

A summary of stability analyses for the maximum bulkhead (non-overflow) and spillway (overflow) section exists and was available for analysis.

2.2 Construction

The only available data on construction uncovered for this report are the reports in the files of the N.J. Department of Environmental Protection relating to the quality of the rock in the foundation. A first report described decayed rock being exposed, but a later report tells that the decayed rock had been removed and that the foundation "rock is satisfactory for construction" according to the inspector from the New

Jersey Bureau of Geology. The river wall, according to another report, is founded on materials of a "sound nature" consisting of large boulders, various sized stones, and a silty soil mixed with fine sand materials.

2.3 Operation

Daily records are kept of the water level behind the dam. The recording device at the time of the inspection visit was not operating and water levels were read from a staff gage on the left abutment. Rainfall amounts at the dam site are also recorded on a daily basis.

The operation of the dam is based on keeping the reservoir at a level designed to capture the maximum volume of water. The automatic operation of the bascule gate limits the level of the reservoir, and an inspection of the water level records, for a sample year 1971, showed that a pool elevation of 743.3 was not exceeded during the year. Typically, 82 mgd of raw water is being withdrawn from the reservoir for water supply use for the City of Newark.

The Charlotteburg Reservoir receives water from the Pequannock River and its tributaries. There is another reservoir upstream of Charlotteburg Dam on the main stem of the Pequannock River, at Oak Ridge, at elevation 852.5, having a drainage area of 21.7 square miles, a storage of 12,000 AF and a reservoir water surface area of 482 acres. A reservoir exists on Pacock Brook, a tributary of the Pequannock River flowing into it some 3 miles above the Charlotteburg dam axis, at elevation 997.5 with a drainage area of 10.5 square miles, a storage capacity of 10,800 AF and a lake surface of 423 acres. Charlotteburg Reservoir can draw water from Echo Lake Reservoir on the Macopin Creek at elevation 902, having a drainage area of 4.6 square miles, a storage capacity of 4,850 AF, and a water surface area of 280 acres. The overflow water from Echo Lake Reservoir however, flow into Macopin Brook downstream of the Charlotteburg Dam axis.

During the dry summer months the water supply demands deplete the reservoir, and pool levels 8 to 10 feet below the crest are not uncommon according to the operators.

2.4 Evaluation

a. Availability

The availability of engineering data has been adequate to assess the safety of the structure for the Phase I inspection. Missing data pertains to the depth of curtain grouting and consolidation grouting at the contact plane between dam and foundation rock. A check list of engineering construction and maintenance data is included in Appendix A.

b. Adequacy

The engineering data assembled is considered adequate. Additional desirable data would have been grouting records at the time of construction, which would give a further indication of the tightness of the underlying foundation rock.

c. Validity

There is no reason to suspect that the engineering data acquired is not valid or representative of the dam as it stands. We have checked the contract plans visually with what is actually built and cannot detect any significant deviations without a full scale detailed as built survey.

SECTION 3

3. VISUAL INSPECTION

3.1 Findings

a. General

This dam and its appurtenances are in good condition having been designed according to modern criteria and controls, being of relatively recent construction, and being attended to, and worked out of, all year round.

b. Dam

1. Seepage and Leakage

No seepage or leakage could be detected at the toe of the dam because of backfill at the toe. The inspection galleries showed that here was very little water emanating from the foundation drain holes on the right abutment and virtually none in the left abutment. Of the estimated 3-5 gallons per minute drainage water in the right abutment inspection gallery drainage gutter, 1-2 gallons were coming out of the vertical monolith joint drain between monoliths 11 and 12. This amount of water, though not serious, should be checked periodically to determine its stability.

The upper service gallery located in the spillway at approximately elevation 675.5, had evidence of lift joint seepage on the downstream face in many places. The amount of drainage was not significant, but seepage mineral deposits coat the walls of the gallery wall below the joint plane.

In Monolith 11, there appears to be a defective horizontal lift joint which exhibits through-the-dam leakage for about a 10-ft. width This location is in the right bulkhead (non-overflow) section at approximately elevation 738. The low head on this joint at the time of inspection, (approx. 3 to 5 feet) indicates that the defect must be fairly wide spread in order to leak right through the whole thickness of the concrete, which is 15-ft. thick at this level.

2. Structural Cracking

There is no visible evidence of structural cracking.

3. Monolith Joints

All vertical monolith joints are clearly formed on the outside with no signs or spalling. On the interior, the monolith joints have not been beveled at the inspection and service galleries; as a result these joints present a ragged appearance which does not detract from their utility.

4. Horizontal Construction Joints

In addition to the poor lift joints described in Monolith 11 at elevation 738±, and the accumulation of seepage minerals on the wall surfaces below the lift joint cutting the upper service gallery in the spillway monoliths, there is one other location where there has been deterioration. This is a horizontal lift joint at the approximate elevation 685-690 in spillway Monolith 9. This joint has deteriorated probably due to poor local original concrete quality, aggravated by the erosive action of the water coming down the spillway. The condition, while not serious now, should be attended to within the next cycle of maintenance, preferably within 24 months. There was minor lift joint seepage observed in the gate shaft and upper service gallery.

5. Water Passages

Due to the nature of the design and operation, the water passages were not available for inspection. This included the 48-inch diameter by-pass line and the twin 48-inch lines leading to the 54-inch diameter raw water line. The 30-inch cone valves on the 54-inch raw water line were in a dry well,and could be inspected and operated,and are described below.

6. Foundation

The dam has been grouted from the inspection gallery at a spacing varying from 5 to 6 feet on centers. The grouting appears to be very effective in reducing seepage.

7. Concrete Surfaces

Exterior main dam concrete surfaces appear to be well formed and aligned. The surface on the dam's downstream face are good with less than one percent of local concrete popoff areas over 3-inch aggregate pieces near the formed surface, due to freeze-thaw effects. The ogee crest is well formed and smooth.

The stilling basin walls are smoothly formed. The stilling basin floor was not available for inspection since tailwater covered the dentated end sill, the chute blocks and the floor itself. An inspection of this area is advisable to be done by the owners forces at a convenient time in their maintenance cycle within the next 24-month period.

All interior concrete surfaces were considered to be in good condition.

8. Mechanical Equipment

- Bascule Gate

The major mechanical feature of the dam is a single leaf bascule gate, 200-ft wide by 5-ft high, located on the crest of the spilway. This gate is designed to automatically maintain the reservoir level at a certain preset value, described in Section 1.2

The gate is hydraulically operated by two double acting cylinders; one at each end of the gate. Normally the reservoir water pressure provides the force to open (lower) the gate; however, the cylinders are designed to be double acting so that the gate can be operated (for maintenance purposes) when the reservoir is below the level of the gate.

The bascule gate operating equipment is located in the Intake and Gate House on the left abutment of the dam, adjacent to the spillway. A pressurized holding tank stores sufficient hydraulic fluid to operate the gate through two complete open/close cycles.

Two vickers high speed vane pumps, rated at 5 gpm at 1000 psi, automatically maintain the fluid level in the holding tank. Pressure is maintained in the holding tank at 950-1000 psi by an Ingersoll-Rand two stage reciprocating air compressor. Both hydraulic pumps and the air compressor are driven by electric motors. There is a diesel generator set which can provide power in case of local power failure.

The gate is normally in the automatic mode where control is achieved by a system of float operated high pressure control valves. The gate can also be positioned manually by overriding the float control.

- Water Supply and Drawdown Features

Charlotteburg Reservoir serves as a municipal water supply for the City of Newark. Water is drawn from the reservoir through the intake structure and flows by gravity through a 54-in. concrete coated steel raw water supply line. Water can be drawn from various elevations and is controlled by placement of a spacer among the stoplogs in the intake structure.

There are two intakes for the 54-in. raw water supply line. Each has guides and a seat for a 48-in. Broome gate followed by a 30-inch motor operated cone valve and a 48-inch motor operated sluice gate after which the two lines converge into the single 54-in. raw water line. The level of gate control redundancy is adequate.

The third intake leads to a 48-in. by-pass line for reservoir draw-down. This intake also contains a stoplog slot and guides and a seat for a Broome gate. The line then leads through a 48-in. motor operated sluice gate and to the outlet niche in the left stilling basin wall. In the outlet niche, there is a 30-in. manually operated hollow cone valve.

Also contained in the outlet niche is a 24-inch diameter hollow cone valve leading off the 54-inch diameter raw water line, allowing this line to be drained.

- Additional Mechanical Equipment

A sump pump is provided in the valve chamber to handle any leakage from the cone valves or the chamber walls.

A 10-ton bridge crane is installed below the roof of the Intake and Gate House. This crane handles the stoplogs and the Broome gate for all three intakes. It can also be used to service any of the other heavy equipment in the Intake and Gate House.

A water supply pump located in the valve chamber draws from the reservoir and provides cooling water to the diesel generator.

The Broome gate is stored on the floor of the Intake and Gate House at elevation 750.5. The lifting beam for the Broome gate and stoplogs are stored in recesses in the floor of the Intake and Gate House.

Inspection Check List - Mechanical Items - A summary check list of the mechanical equipment items is given in Table 1.

TABLE 1

CHARLOTTEBURG DAM

MECHANICAL EQUIPMENT INSPECTION - MAY 1, 1978

SUMMARY CHECK LIST

Item	Condition Rating	Operation Witnessed	Remarks
Bascule Gate	S	NO	No backup, see Item 1
Gate	S	NO	Slight corrosion, see Item 2 Seal leakage, see Item 3
Torque Tube	S	NO	
Saddle Bearings	S	NO	
Hydraulic Cylinders (2)	S	NO	Slight leak, see Item 4
Oil Pumps (2)	S	YES	
Air Compressor	S	YES	
Holding Tank	S	NO	
Float Controller	S	NO	
Water Supply Facilities	S	YES	System contains high level of control redundancy
Stop Logs	S	NO	
Broome Gate	S	NO	
Cone Valves (2)	S	YES	
Sluice Gates (2)	S	YES	
Hollow Cone Drain Valve	S	NO	
Reservoir Drawdown Fac.	S	NO	
Stop Logs	S	NO	
Sluice Gate	S	NO	
Hollow Cone Outlet Valve	S	NO	Lubricating oil leak, see Item 6
Outlet Valve	S	NO	
Misc. Equipment			
Bridge Crane	S	YES	
Emergency Diesel Gen.	S	YES	
Water Supply Pump	S	YES	
Valve Chamber Sum Pump	S	YES	Discharge piping blocked, see Item 5

S = Item is satisfactory for performing its intended function

REMARKS TO SUMMARY CHECK LIST OF MECHANICAL ITEMS INSPECTION

General

All mechanical equipment and operating systems on the Charlotteburg Dam are in very good condition and have been well maintained.

Item 1

Bascule Gate: The only notable deficiency lies in the lack of a secondary means of holding the bascule gate in a closed positon. Normally, the gate is held closed by the hydraulic operating system which constantly maintains a pressure of 950-1000 psi in the operating cylinders on each end of the gate. If the system were to develop a leak of a greater capacity than the two high pressure oil pumps can supply (10 gpm), then the gate would eventually open. This could cause the reservoir level to drop to elevation 738.

This situation is believed to be potentially dangerous to persons and/or property. The effect of a failure in the gate operating system would be loss of a considerable amount of water from the reservoir, releasing up to 10,000 cubic feet per second of water without warning. The downstream channel does not have the capacity to handle the resulting flow without flooding the overbank area. Should it occur at a time then the dam is temporarily unattended, this condition could be dangerous to life or property downstream.

It is to be noted that a spillway discharge in the order of 10,000 cfs is much greater than the discharge for the 1903 flood of record which passed 5,850 cfs at the dam site.

There are several possible means of safeguarding against uncontrolled opening of the bascule gate, such as installation of restrictive orifices at critical locations in the hydraulic piping or installation of a ratchet device which would be activated to lock the gate position in the event of a leak. The gate manufacturer, however, should be consulted.

In this way, should a signigicant system leak develop, the rate of gate opening could be limited so that the gate itself would not be damaged by opening too rapidly and slamming against the supports on top of the spillway.

Item 2

The bascule gate shows minor surface corrosion occurring over approximately 10 percent of the visible surface area. At the next available opportunity the entire gate should receive a coat of protective paint.

Item 3

The bascule gate seals in the closed positon leak a considerable amount of water on the right half of the spillway. This condition, while not objectionable in the summer, could lead to excessive ice build-up on the ogee and gate in a severe winter which would exceed the ability of the heaters to control the problem. This would reduce the spillway capacity. This leakage would make dewatering of the stilling basin difficult. The cause for leakage should be ascertained and corrective measures taken.

Item 4

Prior to this inspection, the hydraulic cylinder on the east end of the bascule gate had developed a small leak at the piston rod seal. Operation of the gate was not affected, and the leak eventually stopped. The local operator stated that Allis Chalmers, the original manufacturer of the gate, was scheduled to replace the piston rod seal during July 1978(when the reservoir level is down below the concrete crest).

Item 5

The valve chamber sump pump discharge piping was blocked. The pump at the time of the inspection was temporarily set up to discharge through a hose into a nearby floor drain. The discharge piping was in the process of being repaired.

Item 6

The outlet hollow cone valve for the 48-inch by-pass line located on the left side of the stilling basin had a crack in the operating mechanism housing. As a result, if lubricating oil were placed in the drip feed reservoir, it would run out through the housing. The leak in the housing should be repaired so that proper lubrication can be provided for the operating mechanism.

All remaining equipment was in very good operating condition and in excellent state of preservation.

9. Inspection of the Electrical System

The dam is supplied with electrical power by Jersey Central Power and Light with a 4800V., 3ø overhead line. The line terminates at potheads on a wood pole and continues with underground cables to a transformer vault adjacent to the intake building. The transformers step the voltage down from 4800V. to 240/120V. which then enters the intake building to a 400 a. main disconnect switch.

Before supplying the main power panel, the circuit passes through a manual transfer switch. This transfer switch provides flexibility so that the dam can be supplied either by the normal utility line or an emergency diesel generator.

The main power panel consists of 15 circuits supplying the following loads:

Circuit No.	Description
1	Unit heater 3/4 HP motor
2	Roof exhaust fan 3/4 HP motor
3	Unit heater 3/4 HP motor
4	East and West armature plate heaters, 3.5 kw. with automatic timer

Circuit No.	Description
5	Cone Valve #1,2.6 HP motor
6	Cone Valve #2,2.6 HP motor
7	Air Compressor 5,HP motor
8	Water Supply for diesel generator,5 hp motor
9	Sluice gate #1 operator, 3.9 HP motor
10	Sluice gate by-pass operator, 3.9 HP motor
11	Sluice gate #2 operator, 3.9 HP motor
12	Lighting Pannel
13	Oil pumps, 2-5 HP motors
14	Bridge Crane, 20 HP motor
15	Bascule Gate Heater, 60.2 kw. with automatic timer

The lighting panel supplied power for all the lights on the main operating floor, the three inspection tunnels, outside lighting and sump pump.

The diesel generator is a Jetapower generator set rated at 100 kw., 125 kva., 120/240 volts, 301 a., 60 Hz., 1800 RPM, PF .8, 3ø 4w. temp. rise 50°C Model #CD-10018, Serial #1520-1. The diesel generator was started and operated for several minutes during the inspection. It was observed during the operation of the diesel generator, that the water supply pump went on automatically providing constant water circulation to the system. The water supply pump stayed in operation until the generator stopped.

It was apparent that the original batteries supplied with the generator had been replaced with two larger ones which were located on the concrete floor rather than in the rack furnished with the generator. It was recommended that these batteries be installed on a rack, keeping them off the concrete floor.

The control panel for the diesel generator contains a battery charger which supplies a trickle charge to the batteries while the diesel generator is not in use.

The cone valves were operated during the inspection and the sluice gates were raised and lowered without any apparent difficulty.

The facility had only one sump pump which was in operation during the inspection. However, the sump pit has an overflow drain line and in the event the pump fails, the water level will rise in the pit until it reaches the drain and then flow back into the stilling basin. There is a portable spare sump pump available at the site which can be installed for emergency conditions.

The bascule gate on the dam was not operated during the inspection. The gate is operated by a hydraulic system. The gate has two heaters, one runs through the entire length of the gate and the other is installed at each end where the gate comes in contact with the concrete wall of the dam. The purpose of the heaters is to prevent ice building up where the rotating parts of the gate come in contact with the dam.

The bridge crane, which was located on the main operating floor of the intake building, was used primarily for lowering the emergency stoplogs or the Broome gate for the cone valves. These gates are located between the valves and the reservoir. The crane was operated during the inspection utilizing the controls to indicate the various speeds and modes of operation.

The lighting in the inspection tunnels was found to be in good condition providing adequate illumination. The lighting in the stairwells, intake building upper and lower floors was all in good condition.

The alarm system consists only of an alarm to warn of unauthorized entry into the building. There are no alarms for any of the equipment in the intake house. The operators make a visual check each day to verify that all equipment is operational.

In general, all the electrical equipment appears to be in good condition.

10. Review of the Geological Setting

The general geological setting is shown on Drawing 8, see Plates.

Hornblende granite and gneiss comprise the foundation for the dam. Outcrops examined on the right abutment indicate that the foliation strikes nearly due north and dips between 80° west and vertical.

Jointing has broken the rock into varying-sized blocks averaging over 2 feet in the longest direction. Joint planes are parallel and at diverse angles and dips to the foliation. Joint lengths also vary and are controlled to some degree by the different mineralogy in the gneissic layers.

Results from previous exploration drilling have defined the foundation conditions adequately. The foundation "as-built" drawing indicates that the stream channel and right abutment sections were excavated to firm and hard bedrock. However, the left abutment excavation line intercepted "weathered" bedrock as determined from the drilling program. It is highly likely that the excavation for the left abutment found good foundation rock. This discrepancy between the poor rock indicated in the drill logs and the excavation depth line may be due to a relatively narrow, weak zone parallel to the foliation that was penetrated by a vertical drill hole. A zone(s) of weak rock indicated by drilling may have received dental treatment during foundation preparation.

The water-test information on the drill logs indicate that the rock is relatively watertight. No information was available on the results the grout curtain program. The drains are relieving a very minor subsurface flow indicating that the drains are working and that underseepage quantities are low. No seeps downstream of the dam were observed.

The relatively steep hills along the reservoir show no signs of major instability problems. The steeply dipping metamorphic rocks are

favorably oriented against major slides although toppling-type failure of joint-defined blocks may occur.

The retaining wall structure at the upstream end of the reservoir is founded on sands and gravels. No seepage through the foundation materials was observed.

c. Appurtenant Structures

- River Wall

The River Wall has been designated at N.J. Dam #00547 and will be the subject of an independent safety report.

- Reservoir Area

The reservoir river is generally gentle to moderately sloping, up to about 4 feet above normal maximum pool level, and moderately steeply sloping above that. The river of the reservoir is lightly vegetated with deciduous trees on a relatively shallow soil cover underlain by competent rock formations. The normal high water reservoir line is clearly discernable at approximately elevation 743.5 ± 0.25.

The sedimentation in the reservoir is said to be light because of the upstream reservoirs (Canistler, Echo Lake, Clinton and Oak Ridge) which intercept and detain the run-off from the Pequannock River and its tributaries.

- Downstream Channel

The channel is well defined with a rocky and stony stream bed. There is no sign of erosion and undercutting of the banks downstream of the stilling basin.

The overbank slopes are moderately to steeply sloping, solidly covered with grass, and at higher elevations, by brush trees. No recent evidence of water caused damage is visible. A program of controlling excessive bush and tree growth adjacent to the stream channel is recommended.

3.2 Evaluation

The visual inspection revealed that the dam and appurtenances are in overall good condition. Conditions which affect dam's safety are listed below:

1. Non-overflow Monoliths:
   Through-dam leakage in the horizontal lift joint in Monolith 11.

2. Overflow Monolith:
   Eroded and deteriorated lift joint in Monolith 9 at elevation 685-690$\pm$.

3. Stilling Basin:
   Unknown condition of the concrete in the floor, chute blocks and end sill.

4. Bascule Gate
   - Deteriorated paint and local rust spots.
   - Possibility of sudden bascule gate opening caused by failure of hydraulic system.
   - Leaking operating piston rod seal.
   - Deteriorated or misaligned gate seals on right side of gate causing objectionably large volume of leakage water flowing down spillway when bascule gate is fully closed.

5. Miscellaneous:

- Non-functioning automatic pool level recorder.
- A plugged sump pump discharge line leading from cone valve pit in Intake and Gate House.
- Lack of a recorded daily bascule gate position, and calculations of discharges going over the spillway.
- Lack of a program to control bush and tree growth in adjacent area of the stream channel downstream of the stilling basin.
- Lack of a warning system in case of hydraulic failure of the bascule actuating system to visually and audibly warm the dam tender or water treatment facility operator that the hydraulic system has failed and that the gate is lowering. An automatic warning system to police or civil defense officials in the downstream community of Butler is recommended.

The visual inspection check list is included in Appendix A.

Photographs taken during the site inspection are included in Appendix B.

SECTION 4

4. OPERATIONAL PROCEDURES

4.1 Procedures

Charlotteburg Dam was built to increase the firm yield of the Pequannock River basin for water supply purposes and to improve the water quality before it enters the Pequannock Aqueduct. The existing impoundments, prior to construction of Charlotteburg Dam, did not have the proper impounding capacity in relation to the size of their drainage areas. As a result, water was wasted over the Macopin Dam before the reservoirs upstream were filled. Water from the existing dams was transmitted to Macopin Dam in open channels, with the result that the water quality in the Macopin reservoir was poorer than that on the upstream reservoirs. With the construction of Charlotteburg Dam a properly sized impoundment was installed to capture as much water as possible from the Pequannock watershed. The water quality was maintained by extending the Pequannock Aqueduct upstream from Macopin Dam to Charlotteburg Dam, and interposing a screening chamber and an aeration and chemical conditioning facility along the extension.

Charlotteburg dam and reservoir are operated and maintained in conjunction with the screening, aeration and chemical treatment facilities downstream of the dam axis. The dam is visited daily to record water levels.

4.2 Maintenance of Dam

The dam maintenance consists of a weekly walkthrough of the service and inspection galleries. Drainage gutters are cleaned out when the necessity is indicated. The area in back of river wall appears to be maintained by mowing and maintenance of the paved drainage gutter. The

stilling basin has never been dewatered for inspection according to operating personnel at the site.

4.3 Maintenance of Operating Facilities

The dam is visited on a daily basis to read the reservoir gage and to perform routine lubricating and maintenance on the mechanical and electrical equipment. The emergency generator is run once a week to check its operational readiness. The Broome gate is lowered into all three 48-inch water passages once or twice a year to keep the gate guides clear and ready for emergency situations.

4.4 Description of any Warning System in Effect

An emergency procedure has been set up for telephonic notification of officials in Kennelon and Butler in case any unforeseen or unexpected bascule gate opening occurs that would significantly increase the flow over Charlotteburg Dam.

4.5 Evaluation

The operational procedures are based on common sense and are carried out by competent personnel under the supervision of an experienced water supply organization. Operational and maintenance procedures should be more formalized and documented in line with the concern expressed recently over the safety of water impounding structures.

The warning system currently in effect should be improved and made automatic, by actuating a warning system at the dam, at the downstream water treatment plant, and at the downstream communities of Kinnelon and Butler.

S E C T I O N 5

5. HYDRAULIC / HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The Probable Maximum Flood (PMF) hydrograph for the Charlotteburg reservoir in this study was obtained by modifying the published PMF for the Intake Dam on the Pequannock River. The PMF for the Macopin Intake Dam is published in the "Passaic River Basin - New Jersey and New York - Survey Report for Water Resources", dated June 1972, by the New York District, Corps of Engineers as 16,100 cfs, having a drainage area of 63.7 square miles.

The Charlotteburg Dam PMF peak discharge is calculated to be 14,900 cfs as compared with 21,000 cfs adopted in the original design of the dam.

The caluclated PMF hydrograph is presented in Appendix D. This PMF hydrograph has the following characteristics:

Peak discharge	=	14,900 cfs
Time of peak	=	47 hours
Runoff	=	19.47 inches

No reservoir routing was performed since the original Spillway Design Flood (SDF) is 1.4 times greater than the calculated PMF.

According to "Memorandum on Design of Charlotteburg Dam", dated December 3, 1957 by Parsons, Brinckerhof, Hall and MacDonald, the operating procedure for the bascule gate is that the gate will maintain its vertical position and impound waters to elevation 743 except intimes of flood. During a flood, the gate will remain vertical until an elevation between 743.5 and 744 is reached. With increasing flood waters, the reservoir level would tend to rise above this elevation. The gate is then

automatically lowered so that the reservoir level remains between elevation 743.5 and elevation 744 until the spillway discharge equals about 11,000 cfs; at this point, the gate is completely lowered. Should the flood flows increase beyond 11,000 cfs, the reservoir level would rise until the peak of the flood occurs. For the design maximum probable flood of 21,000 cfs, the reservoir level would rise to a maximum elevation of 747.1 feet. As the flood recedes, the gate will remain in the lowered position until the reservoir level returns to an elevation between 743.5 and 744, at which time the gate will automatically start to rise to maintain this elevation. At the end of the flood, the gate will once again be vertical and the reservoir full.

The bascule gate consists of a steel torsion cylinder extending the full length of the spillway with steel ribs attached at intervals supporting the plain steel skin on the upstream side. The torsion cylinder extends through armature plates at each end of the gate. The control mechanism is located in the gate chamber. Seals are provided at the end and bottom of the gate so that watertightness is obtained in the vertical position. Electric heaters prevent freezing of the seals. The operating mechanism and controls are hydraulically operated and consists of steel hydraulic cylinders designed for oil pressure not less than 500 pounds per square inch. The oil pressure pumping system consists of duplicate motor driven oil pumps complete with pressure switches and an accumulator sized to hold the gate in position for 24 hours after the loss of electric power supply. While the gates are normally operated automatically, controls have been provided for manual operation. Failure of the operating mechanism will cause opening of the gate resulting in the maximum spillway capacity.

In the original design, probable maximum rainfall values were taken from Hydrometeorological Report #33 with the following distributions:

Duration of Storm	Maximum Probable Rainfall
Hours	Inches
3	18.4
4	20.9
12	23.7
24	25.7

An initial loss of 0.3 inch and an infiltration loss of 0.02 inch per hour were used to determine the runoff producing rainfall.

A one-hour unit hydrograph was derived from analysis of the records available for the floods of October 1903, March 1936 and August 1935 for the entire drainage area and adjusted for application to the area upstream of the Charlotteburg Dam. However, this unit hydrograph has not been included in the design report.

The Reservoir Inflow Hydrograph for the probable maximum flood was obtained by applying the unit hydrograph to the maximum probable rainfall for the storms of 3, 4, 12 and 24 hour durations with initial and infiltration losses rates as mentioned earlier. This PMF inflow hydrograph is given in Appendix D. The peak discharge is 21,100 cfs.

The routing of the PMF through the reservoir, according to the same design memorandum, indicates the maximum outflow through the spillway is 20,500 cfs with the reservoir elevation at 747.1.

b. Experience Data

Records of daily reservoir stage level are maintained since the reservoir was in opreation since 1961. The reservoir water level usually is lower than 743, with only a few occasions where the water level in the reservoir was above 743.25. There is not any record of the water surface exceeding elevation 744.

Stream flow records of the U.S. Geological Survey indicate that the maximum recorded discharge over the Macopin Intake Dam was about 6,100 cfs and occurred on October 10, 1903. Charlotteburg Dam spillway was designed to pass safely a probable maximum flood "inflow" of 21,100 cfs which is considerably greater than the 1903 flood, and the probable maximum flood inflow of 14,900 cfs calculated in this report. The 1903 flood was the most severe of record on the Pequannock River watershed.

c. Visual Observations

It was noted that the automatic level recorder inside the gate chamber was not functioning and all the water level readings were taken manually in the reservoir. The sedimentation does not appear to be excessive and recent developments in the drainage basin should not cause an increase in the sediment load.

The channel immediately downstream of the dam poses no apparent hazards to the safety of the dam or to the stilling basin. However, cleaning of the brush and small tree growth along the river channel is recommended.

d. Overtopping Potential

Since the flood inflow used in the original hydrologic and spillway design is significantly greater than the PMF, the overtopping potential of the Charlotteburg Dam is extremely remote.

e. Reservoir Drawdown

The reservoir drawdown below the spillway crest elevation 738.0, is accomplished by permitting discharge through the 48-inch steel blowoff pipe into the stilling basin and through he 54-inch water supply pipe which discharges approximately 1,500 feet downstream at an approximately invert elevation 670.0. Assuming drawdown to the top of this outlet pipe at the dam which corresponds to elevation 679.5, and an inflow rate of 107.4 cfs (2 cfs/acre) the total drawdown time is approximately 16.8 days. Assuming no inflow into the reservoir, the drawdown time is reduced to approximately 11.6 days.

SECTION 6

6. STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The features determining the stability of a gravity dam are the drainage and grouting details designed to limit seepage under the dam and the uplift forces under it. In the case of Charlotteburg Dam a cut-off grout curtain has been provided together with a drilled drainage system downstream of the grout curtain. The amount of seepage water entering from the drainage holes is a measure of the efficiency of grouting curtain. As observed, the amount of water emanating from the drains in the right non-overflow and spillway sections is very low, estimated at between 3 to 5 gallons per minute, which included leakage from vertical monolith drains. In the left non-overflow section, there was virtually no drain water in the gutter. These signs indicate that the curtain grouting program was effective in cutting off the reservoir head water and that the drains are limiting uplift according to the design assumptions.

b. Design and Construction Data

A summary of design stability loading cases and results was available for review. The loading cases analysed in the design are given below:

1. Spillway Section

Case 1: Dead weight of dam, reservoir empty, earthquake acting in the upstream direction (0.1g).

Case 2: Deadweight of dam, reservoir level at elevation 736.0, ice sheet 2-foot thick floating on top of elevation 736, no tailwater, two thirds head water uplift, backfill to elevation 668.

Case 2a: Same as Case 2, but earthquake forces added in the downstream direction (0.1g).

Case 3: Deadweight of dam, reservoir at elevation 747 (spillway design flood), tailwater at elevation 676, two thirds head water uplift, full tail-water uplift backfill to elevation 668.

2. Non-overflow Section (Bulkhead Section)

Case 1: Same as for Spillway Section.

Case 2: Deadweight of dam, reservoir level to elevation 741.0, ice sheet 2-foot thick floating on top of elevation 741.0 (full pool condition), no tail-water, two thirds head water uplift, backfill to elevation 695.

Case 2a: Same as Case 2, but earthquake forces added to the downstream direction (0.1g).

Case 3: Deadweight of dam, reservoir level at elevation 747.0, tailwater at elevation 671.4, two thirds head water uplift, backfill to elevation 695.

The results for the maximum section analysed are given below:

Spillway Section: Analysis for a horizontal plane at elev. 643.0.

	Case 1	Case 2	Case 2a	Case 3
Vertical Stresses, psi				
Upstream face	-	21.5	-9.3	3.0
Downstream face	-	67.0	95.5	67.5
Resultant in Middle	1/3	1/3	1/2	1/3
Sliding Factor $\Sigma H/\Sigma V$	0.1	0.53	0.805	0.80
Shear Friction Factor of Safety	33.0	8.0	5.2	6.15

Non-overflow Section

	Case 1	Case 2	Case 2a	Case 3
Vertical Stresses, psi				
Upstream face	-	12.5	-7.2	4.7
Downstream face	-	73.5	92.3	73.5
Resultant in Middle	1/3	1/3	1/2	1/3
Sliding Factor $\Sigma H/\Sigma V$	0.1	.578	0.762	0.673
Shear Friction Fact. of Safety	36.5	7.25	5.55	6.75

Notes on Stability Computations:

1. The maximum reservoir elevation assumed, elevation 747.0, is conservative since it was predicated on a SDF of 20,500 cfs. The SDF calculated is 14,900 cfs, resulting in a maximum pool elevation of approximately 745.5.

2. According to the original NJ-DEP design review, the assumption of a 2-ft. sheet of ice exerting 10 kips per foot is conservative, since ice pressures of this magnitude are not usually considered in these geographical locations.

3. The uplift assumption of 2/3 head water at the heel of the dam,varying linearly to full tailwater is fully justified in view of the grout curtain and downstream drainage holes drilled from the inspection gallery, and the open, ungrouted monolith joints.

4. Seismic analysis included 0.1g earthquake forces on the dam concrete and reservoir water. The dam is located in a Zone I Seismic Region for which seismic loadings are usually not considered.

5. The sliding factors for the maximum pool condition at elevation 747 are given as 0.80 for the spillway section and 0.673 for the non-overflow section. Assuming that the contact place between dam and the sound rock formation has an internal angle of friction $\phi = 45°$, whereby $\tan \phi$ is equal to unity, the calculated safety factors against sliding are 1.25 and 1.33 respectively. These factors are considered acceptable for the condition listed.

6. The shear friction factor of safety listed are in excess of the minimum factor of 4 required by the Corps of Engineers. In computing the shear friction factors of safety, a unit shearing strength value of 125 to 150 psi has apparently been used which is considered acceptable.

7. The actual foundation elevations of the as-built dam correspond closely to the maximum design sections analysed.

8. The stability calculations were spot checked, and reasonably close agreement was arrived with listed values in the design stability summary.

In summary, the stability analyses were carried out according to currently accepted loadings and satisfy currently acceptable criteria. Conservative assumptions were used in regard to the pressures and seismic loadings.

c. Operating Records

As far as is known, the maximum reservoir level has never reached level above elevation 743.4. An interview with the Chief of Water Plant Operation disclosed that the leakage and seepage observed in the inspection gallery is typical of the conditions since the completion of the dam. No records have been kept of seepage and leakage volumes to document his claim.

d. Post Construction Changes

There are no known post construction changes that affect the stability of the dam.

e. Seismic Stability

Even though the dam is located in Zone 1 Seismic Probability Region which does not require seismic loadings analysis, it was analysed by the designer for 0.1g pseudo static seismic load and satisfied conventional stability criteria under these loadings.

S E C T I O N 7

7. ASSESSMENT / REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety

The dam has been inspected visually and a review has been made of the available engineering data. This assessment is subject to the limitations inherent in the visual inspection procedures stipulated by the Corps of Engineers for Phase I Report.

- The geologic formation on which the dam is built is competent and, in combination with the curtain grouting and drainage holes installed, has effectively produced a tight headwater barrier. No signs of unusual foundation leakage could be detected visually.

- The hydrologic investigations have determined that the spillway design flood used is in excess of the PMF by about 38 percent. (SDF 20,500 cfs; PMF 14,900 cfs).

- The review of stability investigations showed that acceptable loadings cases have been considered and that the results of these loading cases meet currently acceptable stability criteria. The stability criteria have been met on the assumption that the concrete and rock have a minimum internal friction angle ø of 45 degrees and that the unit shear strength of concrete, rock and their mutual interface have a unit shearing strength of at least 150 pounds per square inch.

- The automatic bascule gate could lower in a short time span in case of a hydraulic piping system failure. If the reservoir is full at the time of such a hypothetical failure, the stream flow would exceed the flood of record by approximately 85 percent. Such high stream stages, starting suddenly and possibly without adequate warning could result in property damage and possibly loss of life downstream.

It is recommended that the owner, in concert with the manufacturer of the gate, devise a suitable modification to the gate operating mechanism to prevent the sudden opening of the gate in case of hydraulic piping failure. It is further recommended that until such a modification is installed, that the reservoir level be maintained at a lower elevation.

For preliminary evaluation purposes, it has been assumed that sudden stream flows exceeding the current 50-year river flow would be dangerous to downstream residents. For the Pequannock River, the 50-year discharge at Mocopin Reservoir is 4,000 cfs. The corresponding head on the spillway of Charlotteburg Dam required to pass 4,000 cfs is approximately 3.2 feet, assuming the gate is in the fully lowered position by failure of its hydraulic operating system.

Accordingly, it is recommneded that the reservoir be maintained at no higher than elevation 741.2 until the gate has been modified to prevent its sudden opening by failure of its hydraulic piping system.

Other recommended actions are:

1. <u>Non-Overflow Monoliths</u>:
   Investigate through dam leakage in horizontal lift joint in Monolith 11 and formulate plan for corrective action.

2. <u>Overflow Monolith</u>:
   Repair lift joint in Monolith 9 at elevation 685-690±.

3. <u>Stilling Basin</u>:
   Dewater basin and inspect floor, chute blocks and end sill for erosion of concrete surface. Inspect and determine if repairs are required.

4. <u>Bascule Gate</u>:
   - Repaint gate.
   - Repack operating piston rod seal to prevent loss of hydraulic fluid.
   - Check bascule gate seals on right side of gate to eliminate objectionably large volume of leakage water flowing down spillway when bascule gate is fully closed.

5. <u>Miscellaneous</u>
   - Repair automatic pool level recorder.
   - Restore plugged sump pump discharge like leading from cone valve pit in Intake and Gate House.

- Record daily bascule gate position and calculate and record discharges going over spillway.

- Initiate a program to control bush and tree growth in adjacent area of the stream channel downstream of the stilling basin.

- Install a warning system in case of hydraulic failure of the bascule actuating system to visually and audibly warn the dam tender or water treatment facility operator that the hydraulic system has failed and that the gate is lowering. An automatic warning system to police or civil defense officials in the downstream community of Butler is recommended.

b. Adequacy of Information

Additional information desirable to fully evaluate the safety of the Charlotteburg Dam are:

- Grouting records for the main dam both for curtain grouting and contact grouting.

- Analysis of rock cores taken at the main dam site to verify the assumed angle of friction, unconfined compressive strength and unit shearing strength.

Outside of these items , the information uncovered during the current investigation appears adequate.

c. Urgency

The recommended actions based on the visual examination are listed in above. Of these, an automatic warning system is case the bascule

gate lowers due to hydraulic piping failure is considered the most urgent. The installation of visible and audible alarms to the dam or treatment plant operators, in case of such a failure, should have the highest priority, together with installation of an automatic warning tie line to police and civil defense officials in the downstream community of Butler. These modifications should be completed within 6 months.

- The reservoir level should be drawdown to elevation 741.2 immediately and maintained at that maximum level until modifications to the bascule gate are completed.

- The modifications to the bascule gate should be formulated within 6 months and implemented within 12 months.

- All other recommneded actions should be implemented within 12 months.

d. Necessity for Further Investigations

From the standpoint of dam safety with regard to the adequacy of the hydrologic design data used and the procedure and methodology in deriving the spillway design floods, routing of the PMF and the capability of the flood discharge structures, the Charlotteburg Dam is safe from overtopping due to a probable maximum flood inflow into the reservoir.

Since the Charlotteburg Dam has a hydrologic capability which exceeds that required by the Corps, it is our opinion that the hydrologic risk failure of this structure as a result of overtopping is extremely minimal.

From the standpoint of stability, the owner should be asked to submit further geologic and foundation grouting data that could verify the assumptions made tothe stability analysis.

Further investigations should be made by the owner to ascertain the causes of the through-dam leakage observed in Monolith 11.

Additional investigations to the extent described above are recommended.

7.2 Remedial Measures

a. Alternatives

The recommneded actions listed in Section 7.1 - a., should be considered. There are no recommneded alternatives.

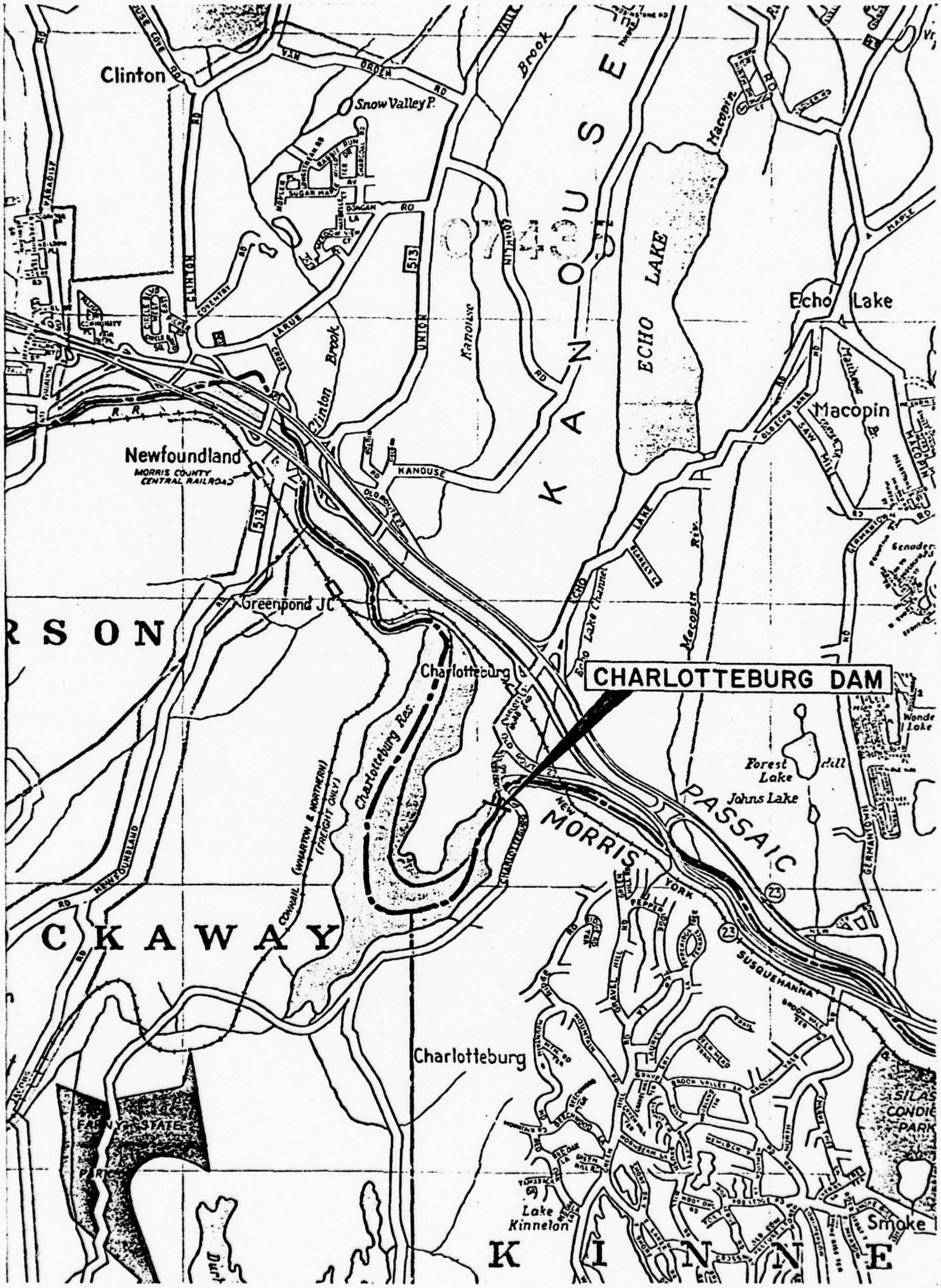
b. O & M Procedures

Existing O & M procedures should be formalized into a periodic O & M check list and log. Items covered in such a list should be:

- All mechanical and electrical equipment
- Foundation drains
- Seepage and leakage surveys at monolith and lift joints
- Surveys of concrete surfaces for surface deterioration and/or cracking. The stilling basin floor should be included in this survey at a 5 to 10-year interval.

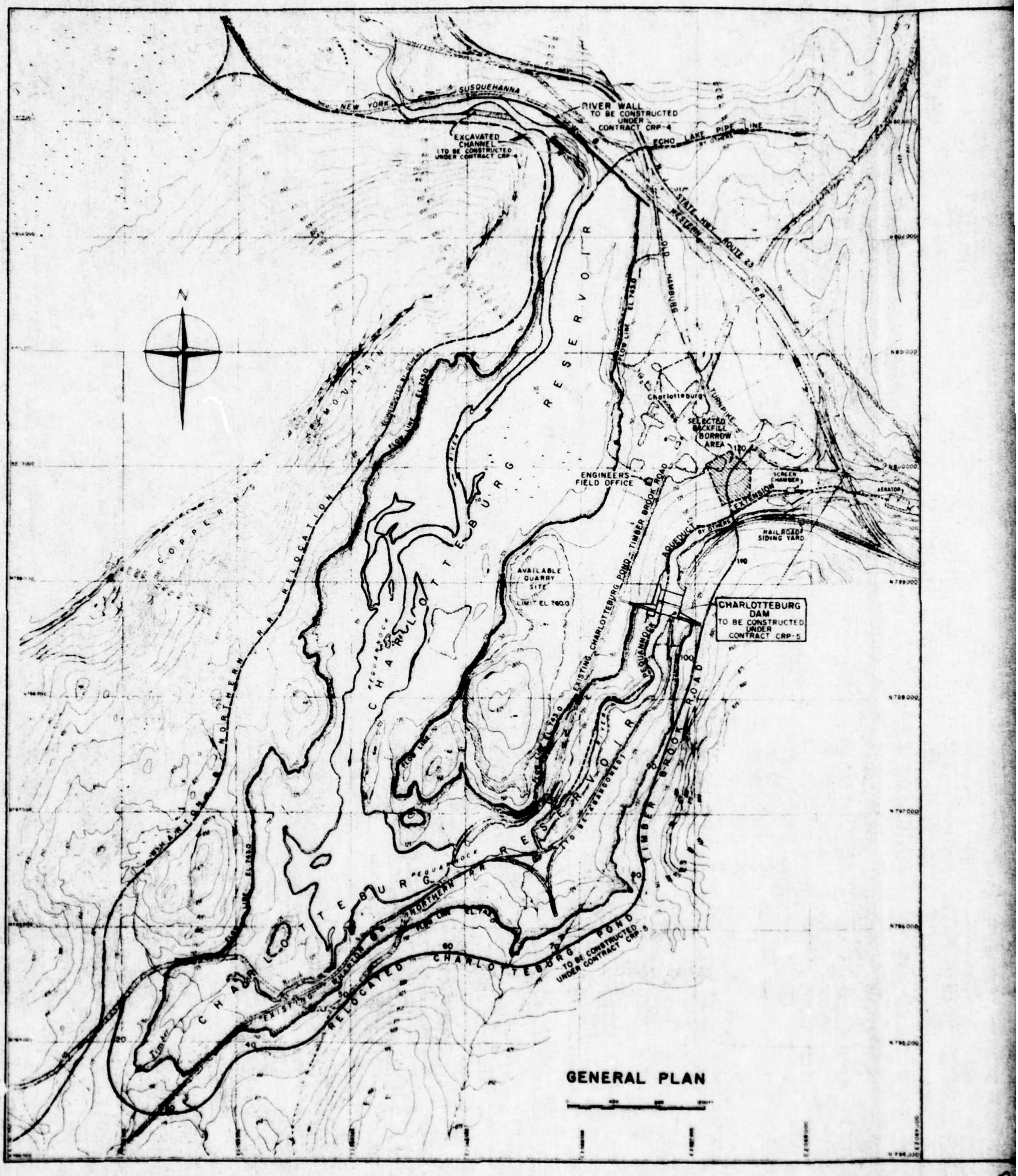
It is recommended that the owner formulate an appropriate O & M check list and log.

PLATES



VICINITY MAP

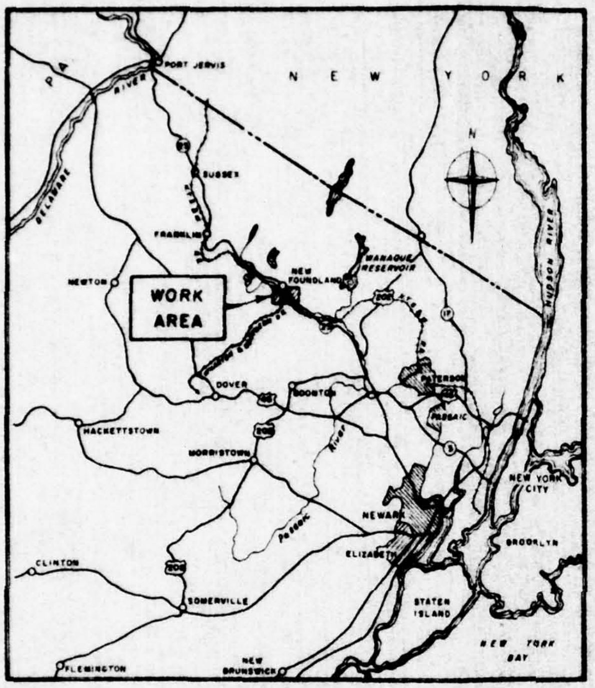
DWG. NO. I



GENERAL PLAN

1

2



LOCALITY MAP

0 5 10 15 20 Miles

APPROVED FOR THE CITY OF NEWARK, N. J.

by [signature]
DIVISION ENGINEER, DIVISION OF WATER SUPPLY — DATE Feb. 14, 1958

[signature]
DIRECTOR, DEPARTMENT OF PUBLIC WORKS — DATE Feb. 14, 1958

DWG. NO. 2

AS BUILT

REVISION	DATE	DESCRIPTION	BY

CITY OF NEWARK, N. J.
PEQUANNOCK RIVER WATER SUPPLY

CHARLOTTEBURG RESERVOIR PROJECT
CONTRACT NO. CRP-2

CHARLOTTEBURG DAM AND RESERVOIR
GENERAL PLAN
AND LOCALITY MAP

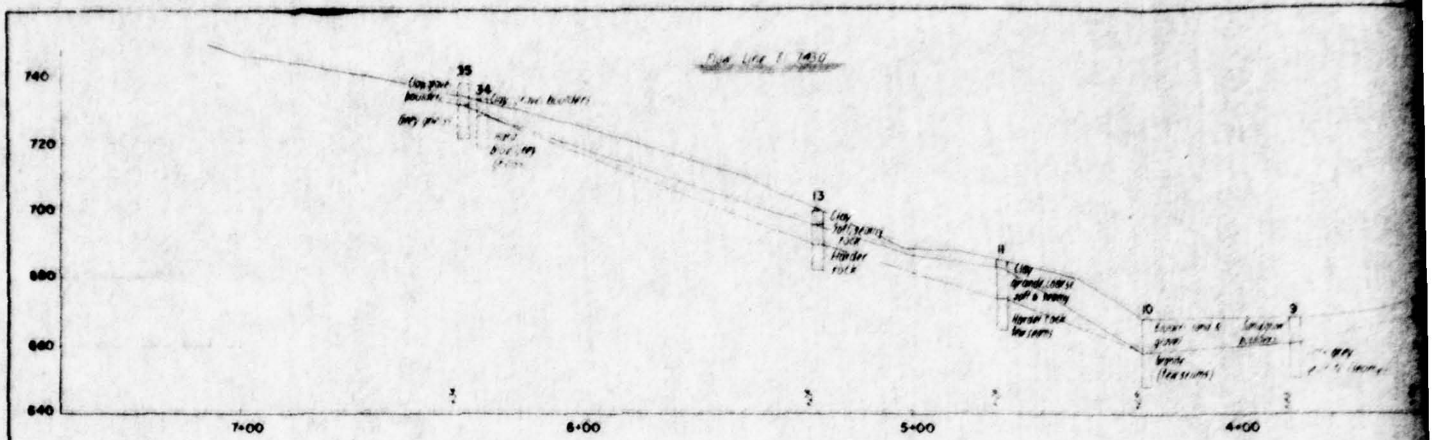
DRAWN J.R.F.
CHECKED C.A.H.
APPROVED H.L.K.

ISSUED AUG 22, 1956
SCALE AS SHOWN

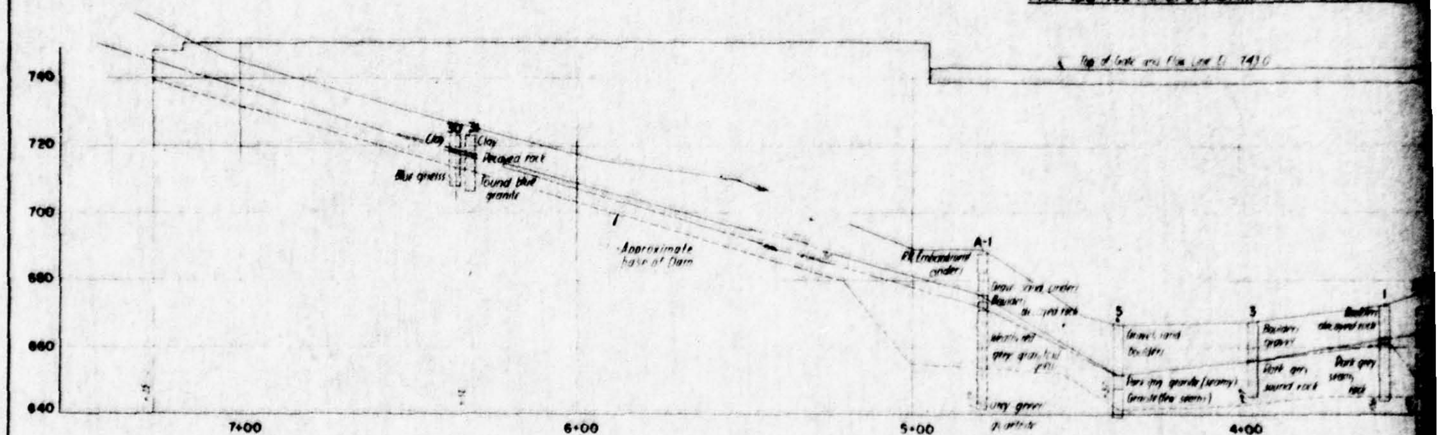
DWG. NO. 1 of 31

PARSONS, BRINCKERHOFF, HALL & MACDONALD — NEW YORK, N. Y.
ENGINEERS G. Gale Dixon ASSOCIATE

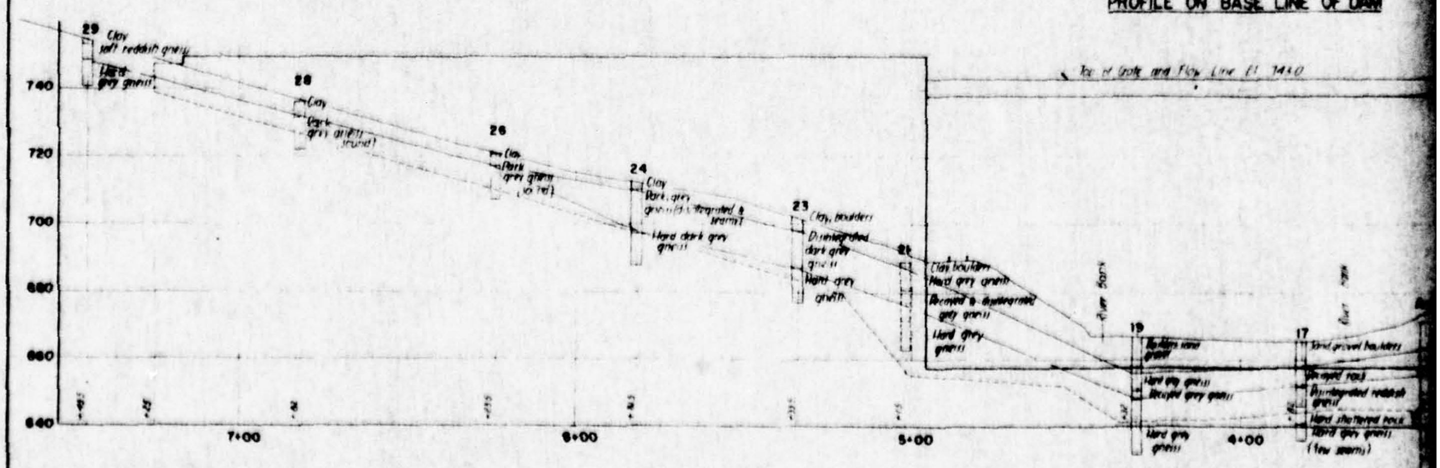
2



PROFILE 135 FT. UPSTREAM FROM BASE LINE

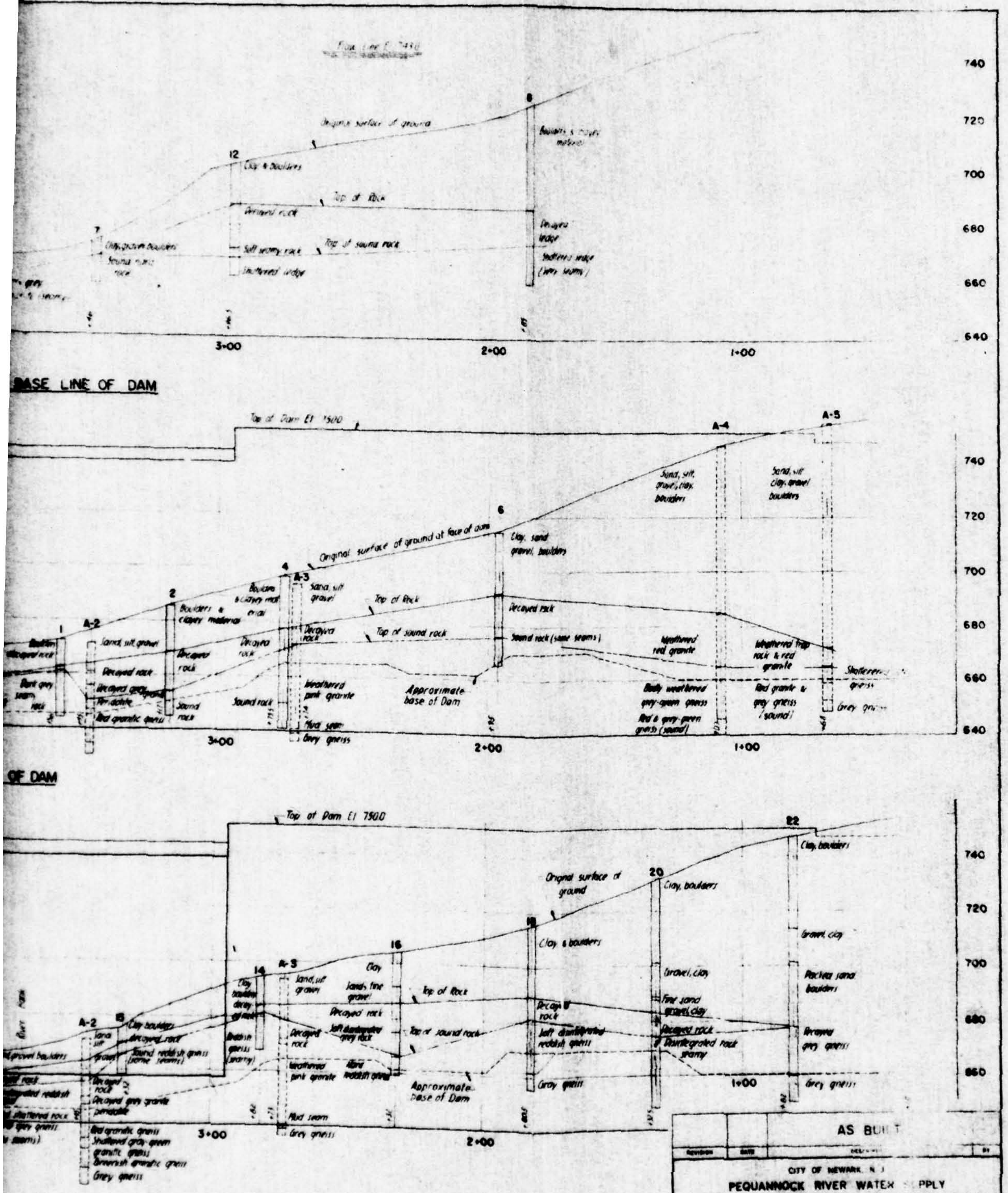


PROFILE ON BASE LINE OF DAM



PROFILE ON "E" LINE

0 20 40 60 FT.



AS BUILT

CITY OF NEWARK, N.J.

PEQUANNOCK RIVER WATER SUPPLY

CHARLOTTEBURG RESERVOIR PROJ

CONTRACT NO CR-5

CHARLOTTEBURG DAM

RECORD OF BORINGS

DRAWN K.B. CHECKED C.A.M. APPROVED H.L.R.

ISSUED SCALE AS SHOWN

3 OF 31

PARSONS, BRINCKERHOFF, HALL & MACDONALD ENGINEERS NEW YORK, N.Y.

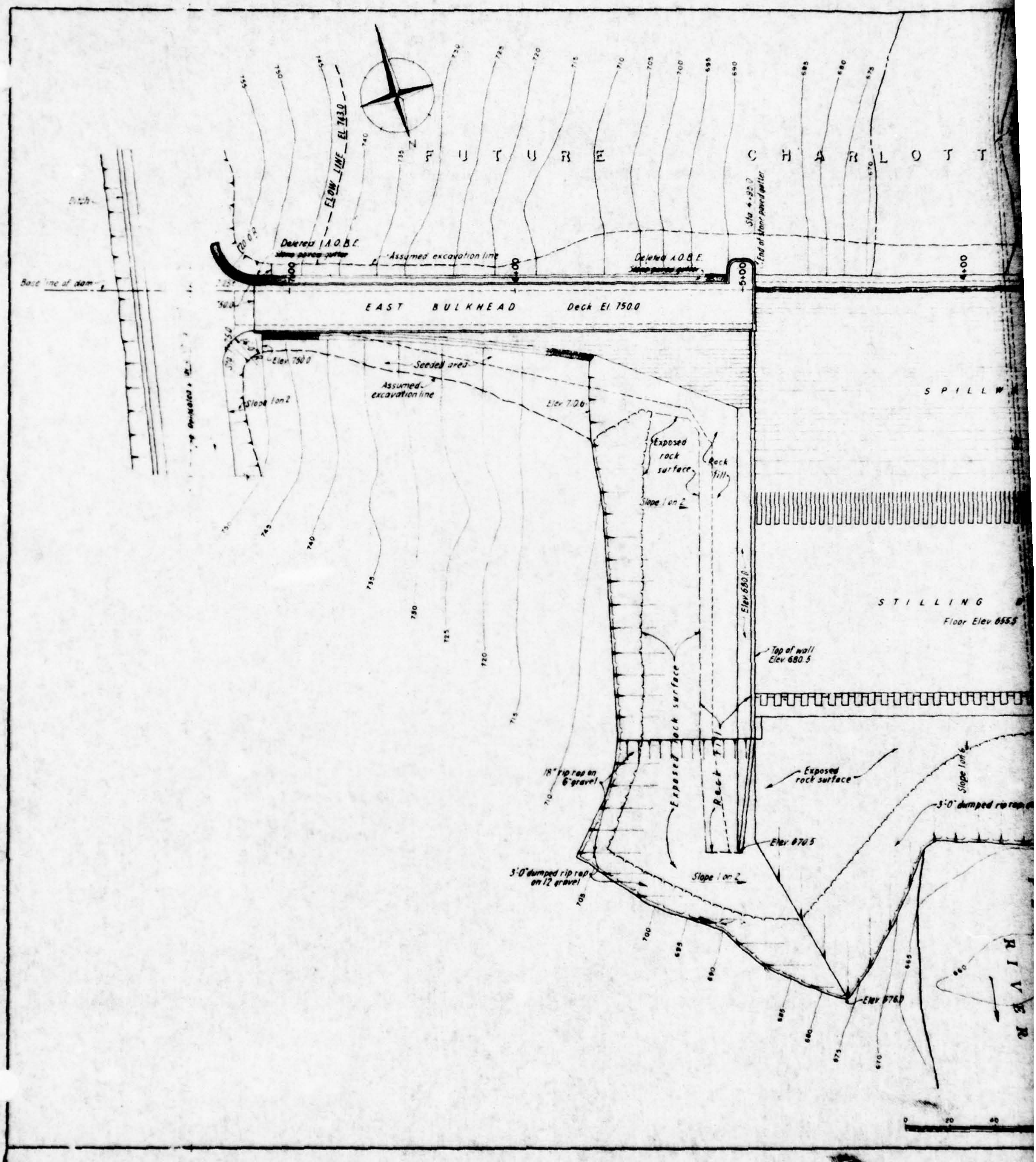
ASSOCIATE

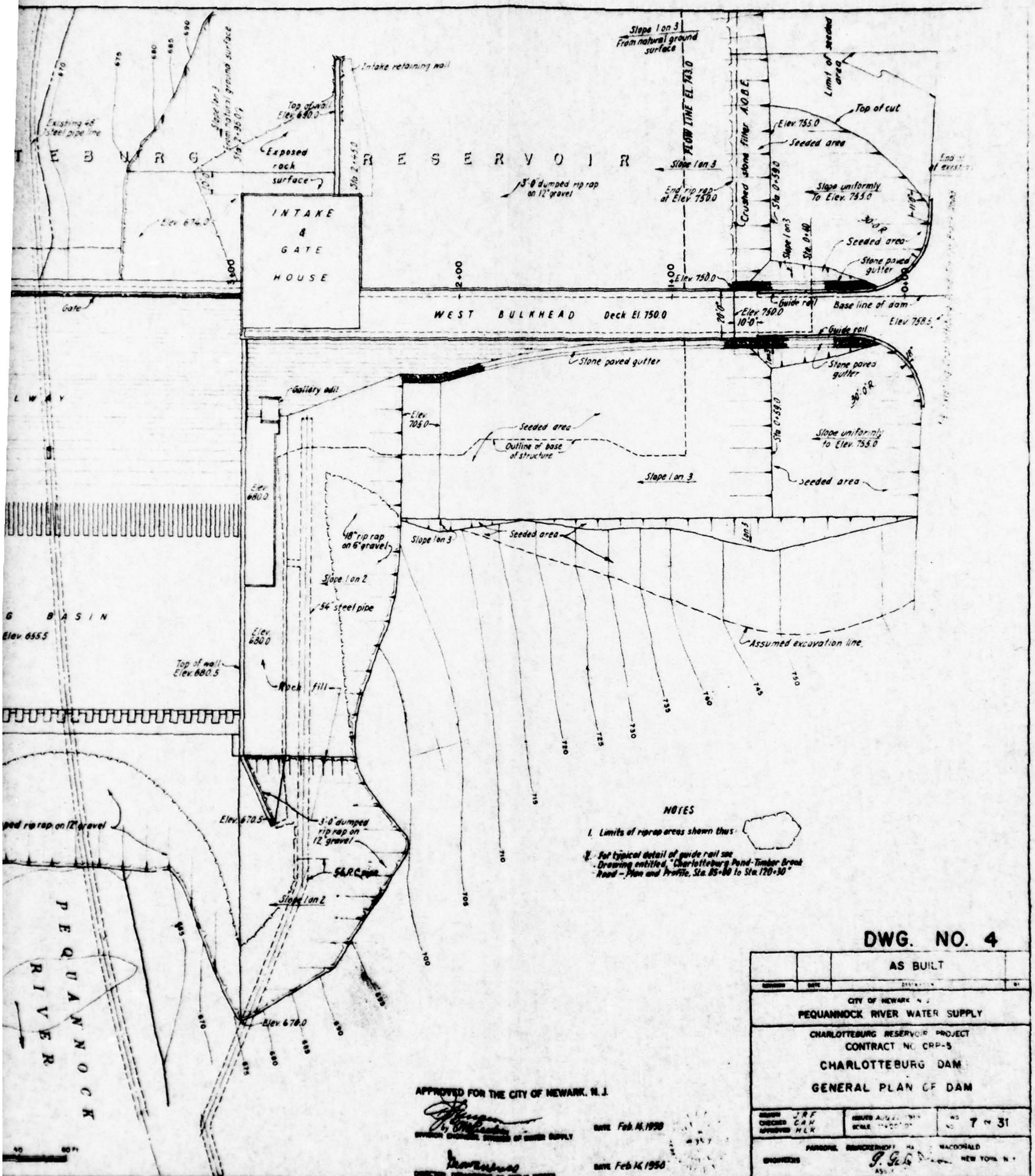
DWG. NO. 3

APPROVED FOR THE CITY OF NEWARK, N.J.

DIVISION ENGINEER DIVISION OF WATER SUPPLY DATE Feb 14, 1958

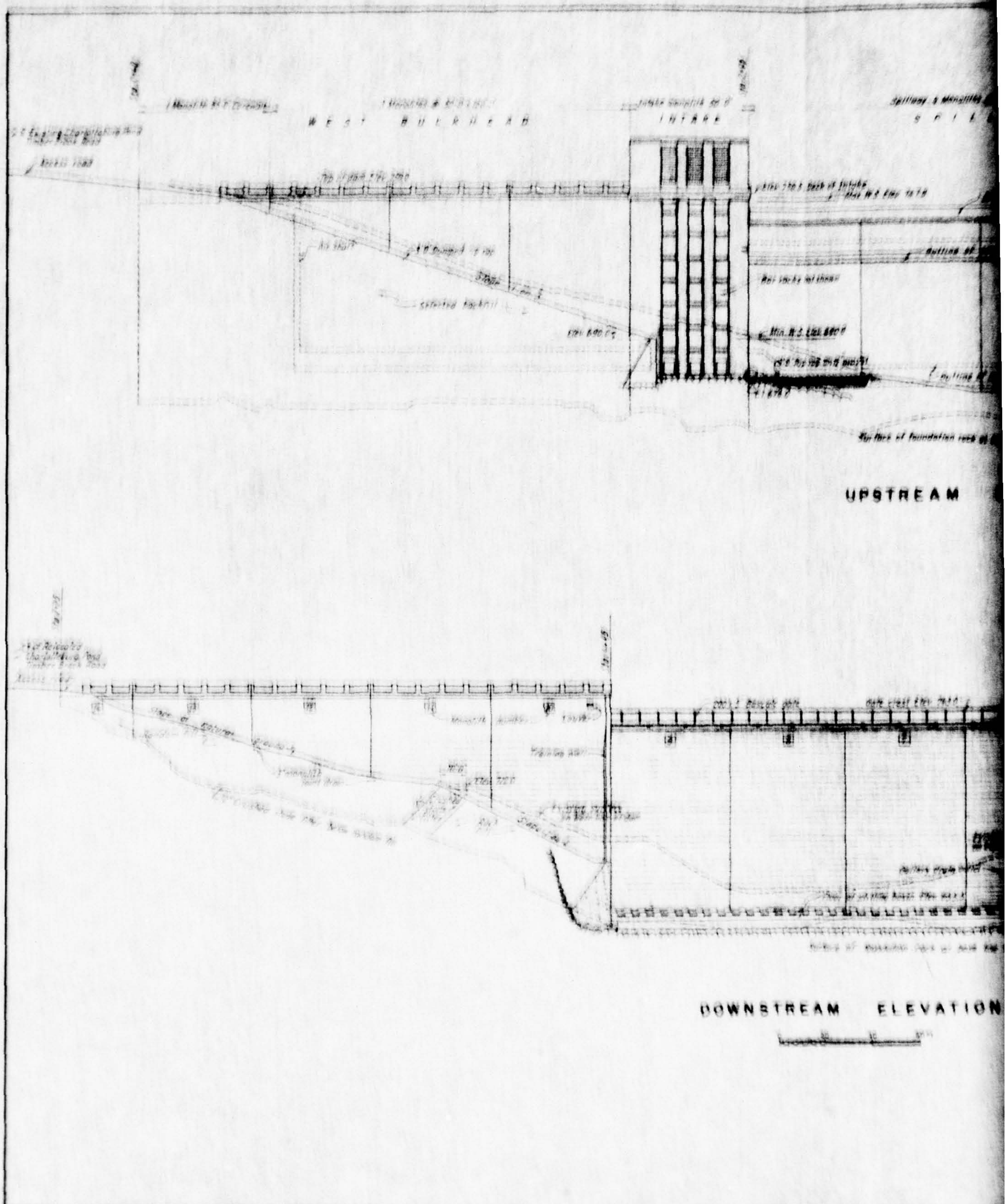
DIRECTOR, DEPARTMENT OF PUBLIC WORKS DATE Feb 14, 1958

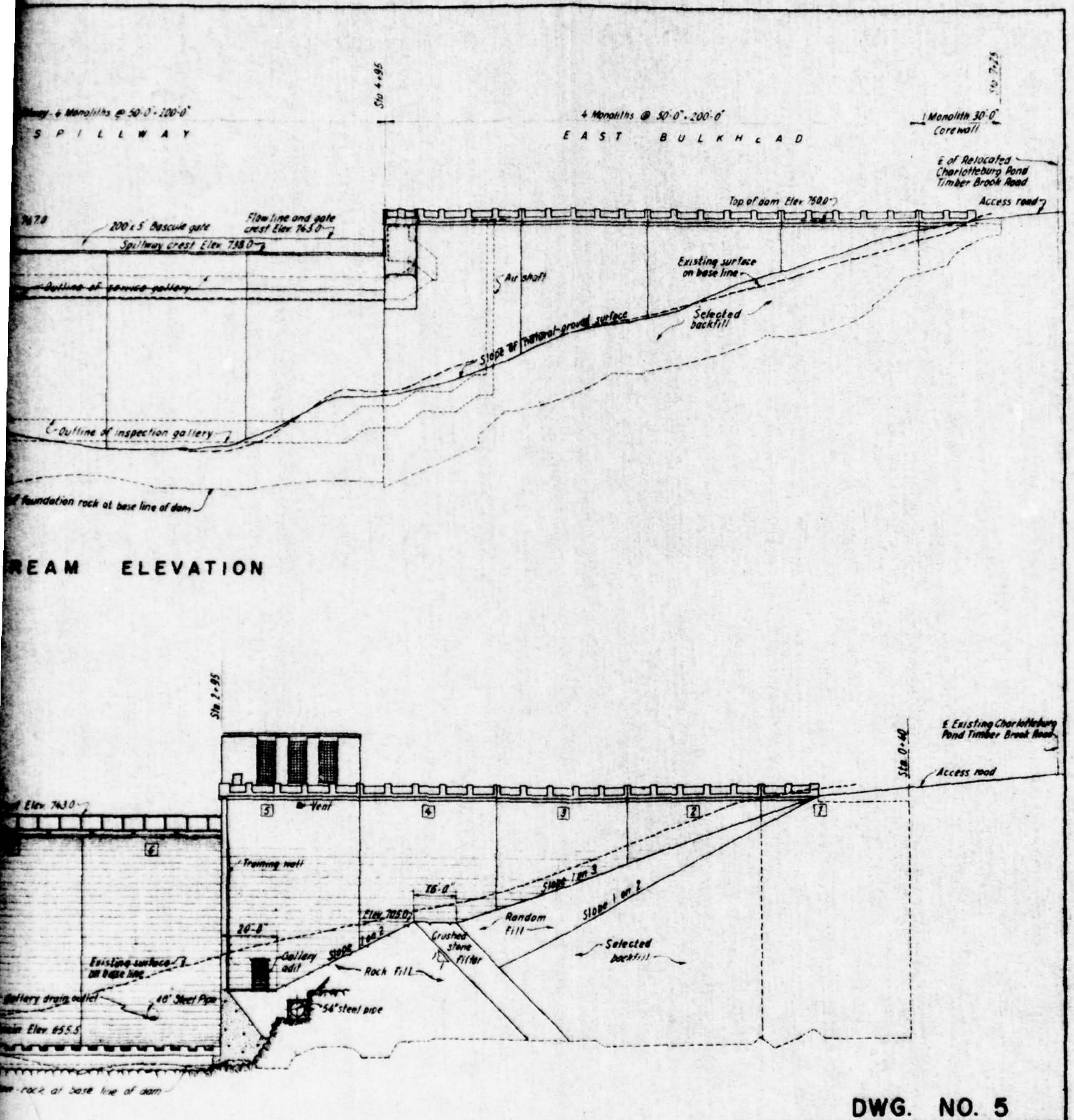

F U T U R E C H A R L O T T
FLOW LINE EL 743.0
Ditch
Base line of dam
Deleted I.A.O.B.E.
Stone paved gutter
Assumed excavation line
Deleted A.O.B.E.
Stone paved gutter
Sta 4+92.0
End of stone paved gutter
5+00
4+00
EAST BULKHEAD Deck El 750.0
Elev 750.0
Seeded area
Assumed excavation line
Slope 1 on 2
Elev 710.0
Exposed rock surface
Rock fill
Slope 1 on 2
S P I L L W
Elev 680.0
S T I L L I N G
Floor Elev 655.5
Top of wall
Elev 680.5
18" rip rap on 6" gravel
Exposed rock surface
Rock fill
Exposed rock surface
3'-0" dumped rip rap
Elev 670.5
3'-0" dumped rip rap on 12" gravel
Slope 1 on 2
Elev 676.0
R I V E R



DWG. NO. 4
AS BUILT
CITY OF NEWARK, N. J.
PEQUANNOCK RIVER WATER SUPPLY
CHARLOTTEBURG RESERVOIR PROJECT
CONTRACT NO. CRP-5
CHARLOTTEBURG DAM
GENERAL PLAN OF DAM
APPROVED FOR THE CITY OF NEWARK, N. J.
DIVISION ENGINEER, DIVISION OF WATER SUPPLY
DATE Feb. 14, 1958
DIRECTOR, DEPARTMENT OF PUBLIC WORKS
DATE Feb. 14, 1958
DRAWN J.R.F.
CHECKED C.A.H.
APPROVED H.L.K.
7 - 31
PARSONS, BRINCKERHOFF, HALL & MACDONALD
ENGINEERS
NEW YORK, N. Y.
NOTES
1. Limits of riprap areas shown thus
2. For typical detail of guide rail see Drawing entitled "Charlotteburg Pond-Timber Brook Road - Plan and Profile, Sta. 85+00 to Sta. 120+30"
R E S E R V O I R
INTAKE & GATE HOUSE
WEST BULKHEAD Deck El. 750.0
PEQUANNOCK RIVER
Intake retaining wall
Top of wall Elev. 690.0
Existing 48" steel pipe line
Exposed rock surface
3'-0" dumped rip rap on 12" gravel
Slope 1 on 3
From natural ground surface
FLOW LINE EL. 743.0
Crushed stone filter A.O.B.E.
Limit of seeded area
Top of cut
Elev. 755.0
Seeded area
End rip rap at Elev. 750.0
Slope uniformly to Elev. 755.0
Stone paved gutter
Guide rail
Base line of dam
Elev. 758.5
Elev. 750.0
Gallery adit
Elev. 705.0
Outline of base of structure
Elev. 680.0
18" rip rap on 6" gravel
Slope 1 on 2
54" steel pipe
Assumed excavation line
Top of wall Elev. 680.5
Rock fill
Elev. 670.5
54" R.C. pipe
Elev. 670.0
Elev. 674.0
Elev. 655.5
Gate

2


WEST BULKHEAD
INTAKE
UPSTREAM
DOWNSTREAM ELEVATION



DWG. NO. 5

AS BUILT

CITY OF NEWARK, N. J.

PEQUANNOCK RIVER WATER SUPPLY

CHARLOTTEBURG RESERVOIR PROJECT

CONTRACT NO. CRP-5

CHARLOTTEBURG DAM

ELEVATIONS OF DAM

DRAWN J.R.F. CHECKED C.A.H. APPROVED H.L.K.

SCALE: AS SHOWN

8 - 51

ENGINEERS PARSONS, BRINCKERHOFF, HALL & MACDONALD NEW YORK, N.Y.

ASSOCIATE

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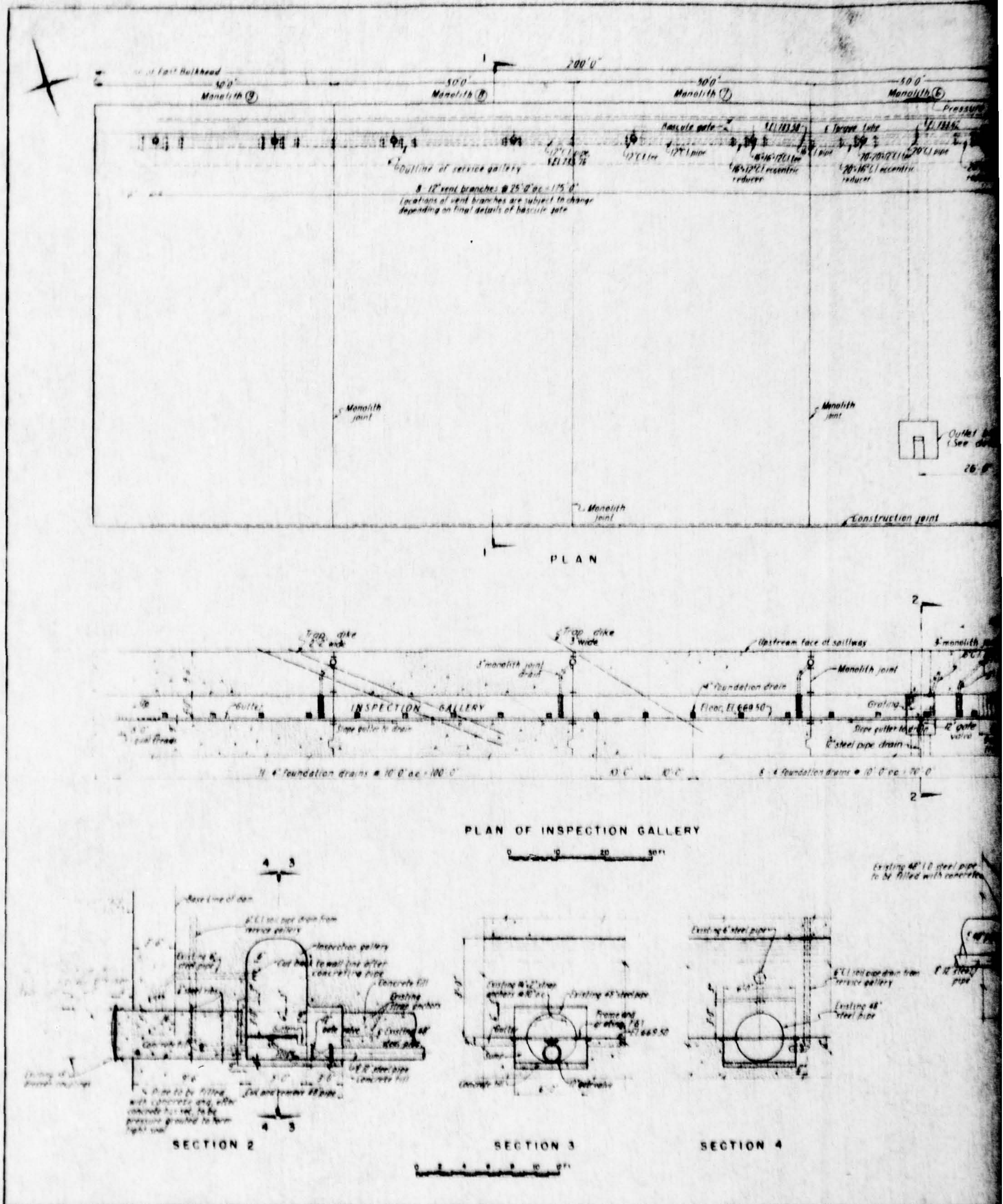
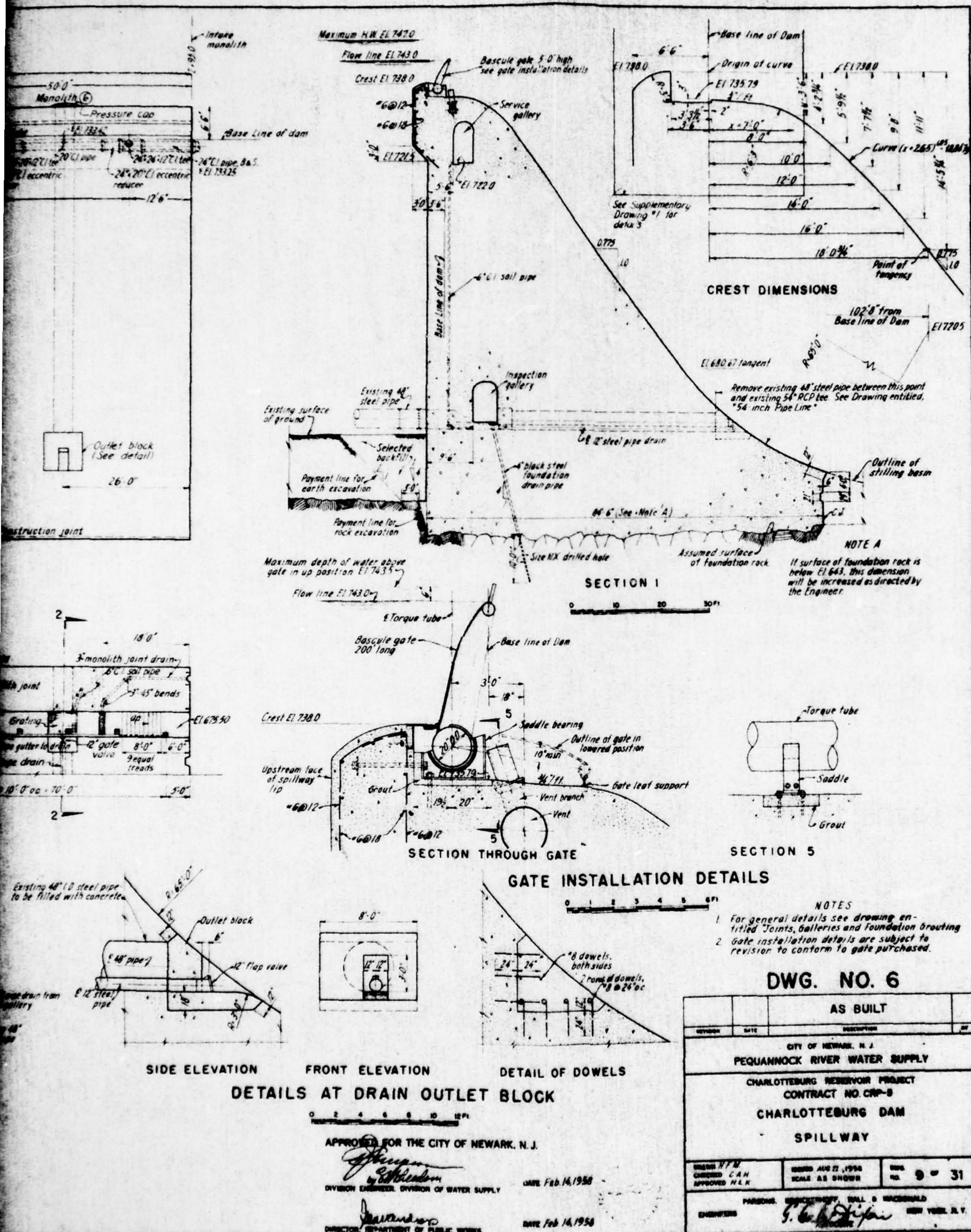
DIVISION ENGINEER, DIVISION OF WATER SUPPLY DATE Feb 14, 1958

DIRECTOR, DEPARTMENT OF PUBLIC WORKS DATE Feb 14, 1958

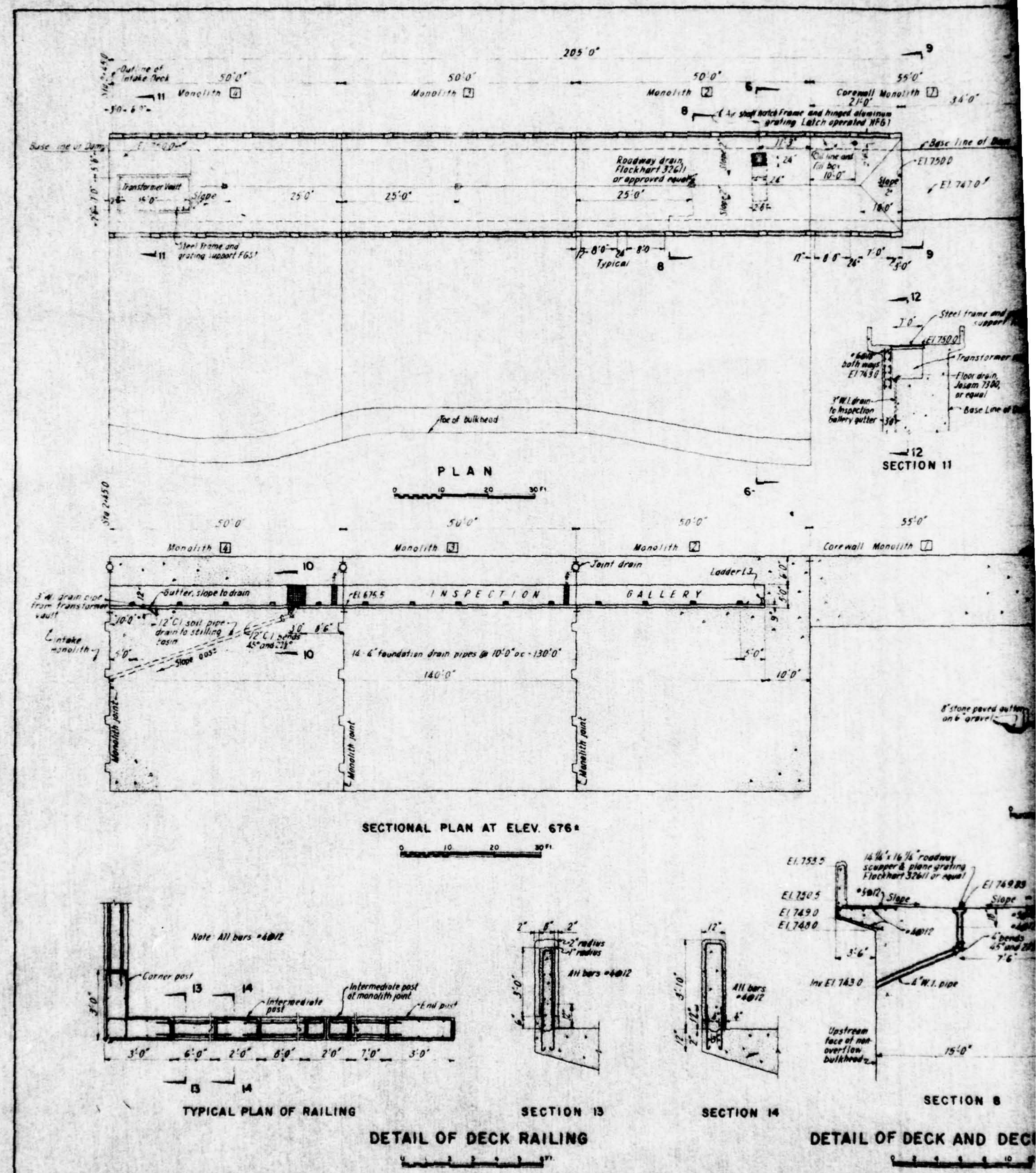
2


East Bulkhead
200'0"
50'0"
Manolith 9
Manolith 8
Manolith 7
Manolith 6
Bascule gate
Torque tube
Outline of service gallery
8 - 12" vent branches @ 25'0" o.c. = 175'0"
Locations of vent branches are subject to change depending on final details of bascule gate
Monolith joint
Construction joint
PLAN
Trap dike
Upstream face of spillway
Monolith joint
INSPECTION GALLERY
Gutter
Slope gutter to drain
Floor, El. 669.50
Grating
12" steel pipe drain
11 - 4" foundation drains @ 10'0" o.c. = 100'0"
8 - 4" foundation drains @ 10'0" o.c. = 70'0"
PLAN OF INSPECTION GALLERY
0 10 20 30 Ft
Base line of dam
Inspection gallery
Concrete fill
Existing 48" steel pipe
SECTION 2
SECTION 3
SECTION 4

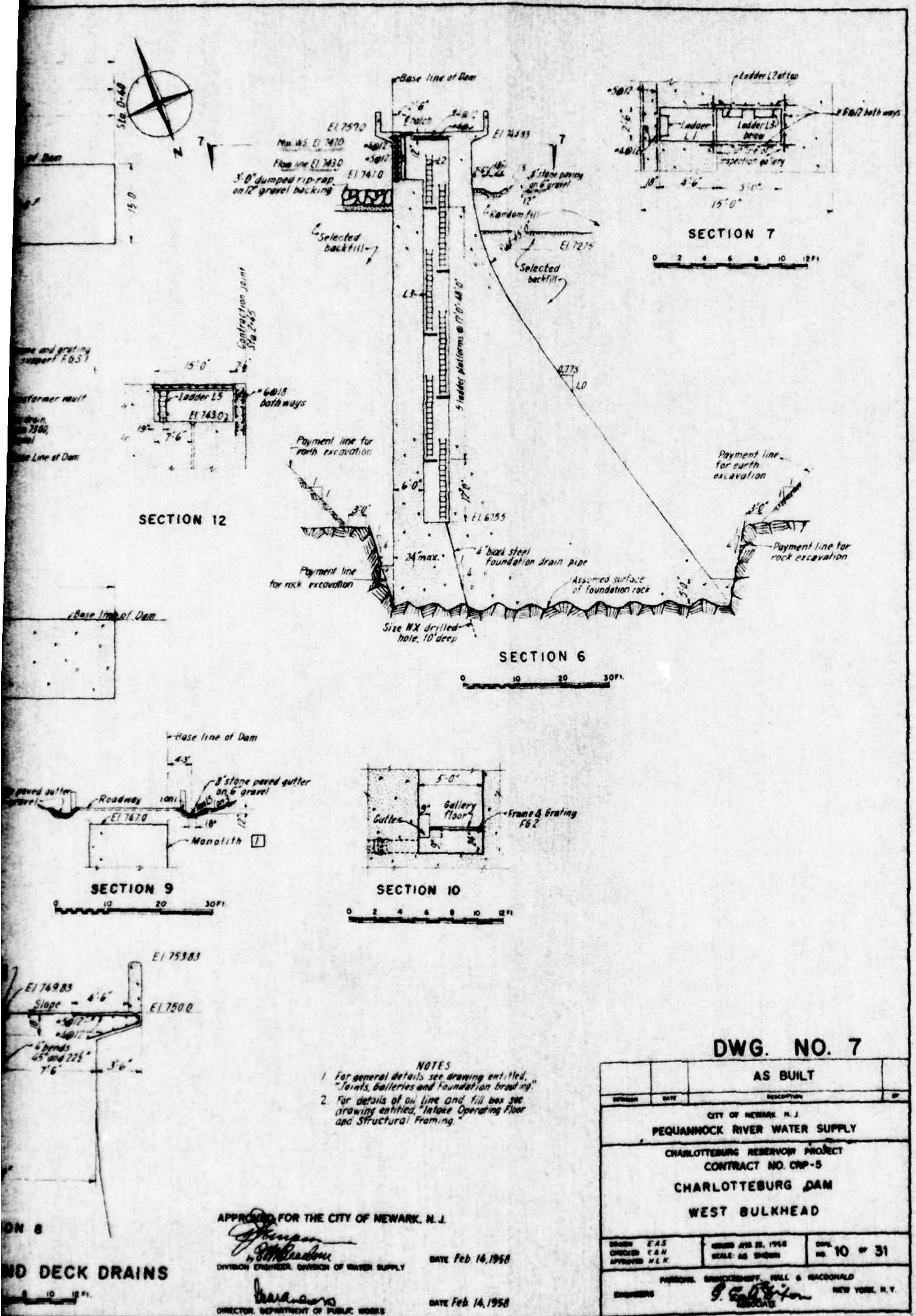


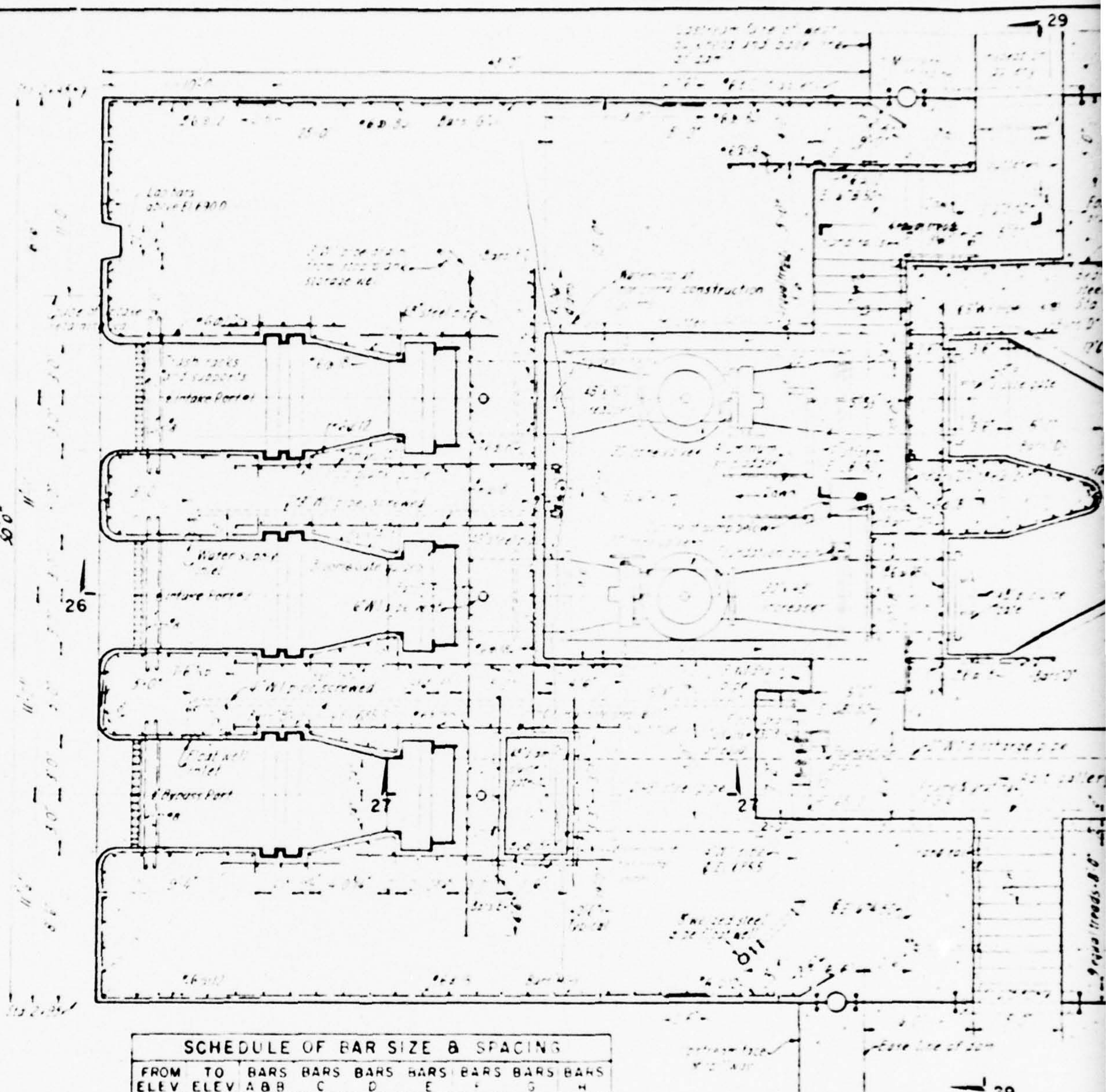
Maximum H.W. El. 747.0
Flow line El. 743.0
Bascule gate 5'-0" high see gate installation details
Crest El. 738.0
Intake monolith
Monolith 6
Pressure cap
Base Line of dam
Service gallery
El. 722.0
Base line of dam
6" C.I. soil pipe
Inspection gallery
Existing 48" steel pipe
Existing surface of ground
Selected backfill
Payment line for earth excavation
Payment line for rock excavation
6" black steel foundation drain pipe
12" steel pipe drain
Size NX drilled hole
Assumed surface of foundation rock
El. 680.67 tangent
Remove existing 48" steel pipe between this point and existing 54" RCP tee. See Drawing entitled, "54 inch Pipe Line"
Outline of stilling basin
84'-6" (See Note A)
NOTE A
If surface of foundation rock is below El. 643, this dimension will be increased as directed by the Engineer.
SECTION 1
102'-8" from Base line of Dam
El. 720.5
Base line of Dam
Origin of curve
El. 738.0
El. 735.79
Curve (x+2.65)^1.85 = 10.062y
Point of tangency
See Supplementary Drawing #1 for datum 3
CREST DIMENSIONS
Outlet block (See detail)
Construction joint
Maximum depth of water above gate in up position El. 743.5
Flow line El. 743.0
Torque tube
Bascule gate 200' long
Base line of Dam
Crest El. 738.0
Saddle bearing
Outline of gate in lowered position
Upstream face of spillway lip
Grout
Gate leaf support
Vent branch
Vent
SECTION THROUGH GATE
Torque tube
Saddle
Grout
SECTION 5
GATE INSTALLATION DETAILS
3" monolith joint drain
8" C.I. soil pipe
45° bends
Grating
12" gate valve
9 equal treads
El. 673.50
Existing 48" I.D. steel pipe to be filled with concrete
Outlet block
12" flap valve
48" pipe
12" steel pipe
8 dowels, both sides
2 rows of dowels, 8 @ 24" o.c.
SIDE ELEVATION
FRONT ELEVATION
DETAIL OF DOWELS
DETAILS AT DRAIN OUTLET BLOCK
NOTES
1. For general details see drawing entitled "Joints, Galleries and Foundation Grouting"
2. Gate installation details are subject to revision to conform to gate purchased.
DWG. NO. 6
AS BUILT
CITY OF NEWARK, N.J.
PEQUANNOCK RIVER WATER SUPPLY
CHARLOTTEBURG RESERVOIR PROJECT
CONTRACT NO. CRP-5
CHARLOTTEBURG DAM
SPILLWAY
ISSUED AUG 22, 1956
SCALE AS SHOWN
9 - 31
ENGINEERS
PARSONS, BRINCKERHOFF, HALL & MACDONALD
NEW YORK, N.Y.
APPROVED FOR THE CITY OF NEWARK, N.J.
DIVISION ENGINEER, DIVISION OF WATER SUPPLY
DATE Feb. 14, 1958
DIRECTOR, DEPARTMENT OF PUBLIC WORKS
DATE Feb. 14, 1958

2



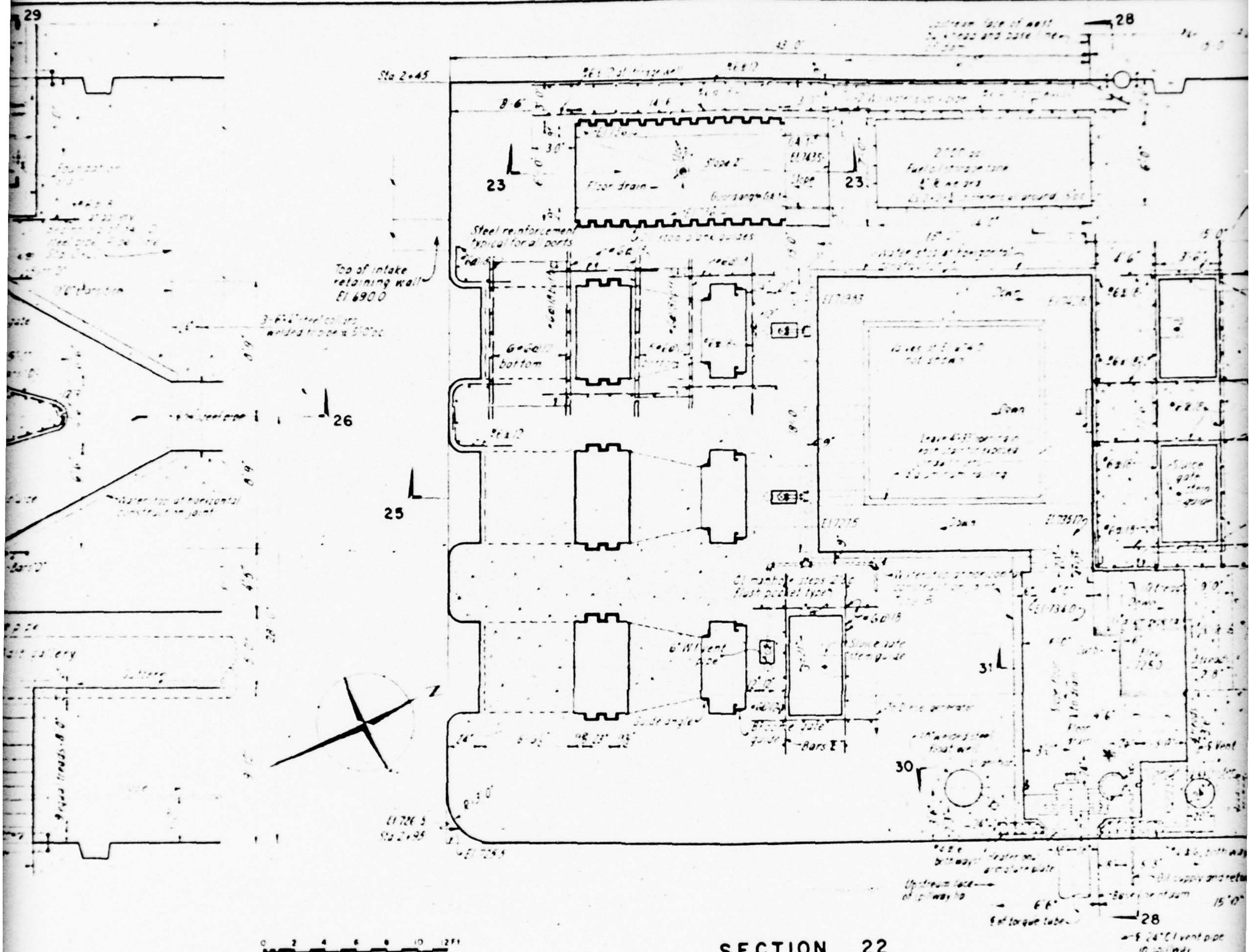
205'0"
Outline of Intake Deck
50'0"
50'0"
50'0"
55'0"
Monolith 4
Monolith 3
Monolith 2
Corewall Monolith 1
21'0"
34'0"
Air shaft hatch Frame and hinged aluminum grating Latch operated HFG1
Base line of Dam
Transformer Vault
15'0"
Slope
25'0"
25'0"
25'0"
25'0"
Roadway drain Flockhart 32611 or approved equal
Outline and fill box
10'0"
El 750.0
El 747.0
Steel frame and grating support FGS1
8'0"
8'0"
Typical
Toe of bulkhead
PLAN
0 10 20 30 Ft
Steel frame and support
El 750.0
Transformer
Floor drain, Josam 7380, or equal
3" W.I. drain to Inspection Gallery gutter
Base Line of Dam
SECTION 11
Sta 2+45.0
50'0"
50'0"
50'0"
55'0"
Monolith 4
Monolith 3
Monolith 2
Corewall Monolith 1
Joint drain
Ladder L3
3" W.I. drain pipe from transformer vault
Gutter, slope to drain
El 675.5
INSPECTION GALLERY
12" C.I. soil pipe drain to stilling basin
12" C.I. bends 45° and 22½°
Intake monolith
Slope 0.032
14-6" foundation drain pipes @ 10'0" o.c. - 130'0"
140'0"
Monolith joint
Monolith joint
Monolith joint
8" stone paved gutter on 6" gravel
SECTIONAL PLAN AT ELEV. 676±
0 10 20 30 Ft
Note: All bars #4@12
Corner post
Intermediate post
Intermediate post at monolith joint
End post
3'0"
3'0"
6'0"
2'0"
8'0"
2'0"
7'0"
3'0"
TYPICAL PLAN OF RAILING
2" radius
1" radius
All bars #4@12
SECTION 13
3'10"
All bars #4@12
SECTION 14
DETAIL OF DECK RAILING
El 753.5
14¼" x 14¼" roadway scupper & plane grating Flockhart 32611 or equal
El 749.83
El 750.5
El 749.0
El 748.0
#5@12
Slope
4" bends 45° and 22½°
3'6"
7'6"
Inv El 743.0
4" W.I. pipe
Upstream face of non-overflow bulkhead
15'0"
SECTION 8
DETAIL OF DECK AND DECK


Base line of Dam
El 759.0
Max. W.S. El 742.0
Flow line El 743.0
El 741.0
3'-0" dumped rip-rap on 12" gravel backing
El 753.83
Selected backfill
Random fill
El 727.5
Selected backfill
5 ladder platforms @ 17'-0" = 85'-0"
Payment line for earth excavation
Payment line for earth excavation
El 675.5
4" bell steel foundation drain pipe
24" max.
Payment line for rock excavation
Payment line for rock excavation
Assumed surface of foundation rock
Size NX drilled hole, 10' deep
SECTION 6
0 10 20 30 Ft.
Ladder L2 at top
Ladder L1
Ladder L3 below
Inspection gallery
15'-0"
SECTION 7
0 2 4 6 8 10 12 Ft.
Contraction joint Sta 2+45
15'-0"
Ladder L5
El 743.0
6@18 both ways
SECTION 12
Base line of Dam
Base line of Dam
8" stone paved gutter on 6" gravel
Roadway
El 767.0
Monolith 1
SECTION 9
0 10 20 30 Ft.
5'-0"
Gallery floor
Gutter
Frame & Grating F62
SECTION 10
0 2 4 6 8 10 12 Ft.
El 753.83
El 749.83
Slope
El 750.0
45° and 22½°
ON 8
ND DECK DRAINS
DWG. NO. 7
NOTES
1. For general details see drawing entitled, "Joints, Galleries and Foundation Grouting."
2. For details of oil line and fill box see drawing entitled, "Intake Operating Floor and Structural Framing."
AS BUILT
CITY OF NEWARK, N. J.
PEQUANNOCK RIVER WATER SUPPLY
CHARLOTTEBURG RESERVOIR PROJECT
CONTRACT NO. CRP-5
CHARLOTTEBURG DAM
WEST BULKHEAD
DRAWN EAS
CHECKED CAN
APPROVED HLK
SCALE: AS SHOWN
DWG. NO. 10 OF 31
PARSONS, BRINCKERHOFF, HALL & MACDONALD
ENGINEERS
NEW YORK, N.Y.
APPROVED FOR THE CITY OF NEWARK, N. J.
DIVISION ENGINEER, DIVISION OF WATER SUPPLY
DATE Feb 14, 1958
DIRECTOR, DEPARTMENT OF PUBLIC WORKS
DATE Feb 14, 1958



SCHEDULE OF BAR SIZE & SPACING								
FROM ELEV	TO ELEV	BARS A & B	BARS C	BARS D	BARS E	BARS F	BARS G	BARS H
674.0	685.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
685.0	695.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
695.0	705.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	725.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
725.0	735.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
735.0	742.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SECTION 21



SECTION 22

APPROVED FOR THE CITY OF NEWARK, N.J.

DIVISION ENGINEER, DIVISION OF WATER SUPPLY — DATE Feb 4, 1958

DIRECTOR, DEPARTMENT OF PUBLIC WORKS — DATE Feb 14, 1958

REVISION	DATE

CITY OF N

PEQUANNOCK RIV

CHARLOTTEBURG

CONTRA

CHARLOTT

INT

SECTIONS

DRAWN

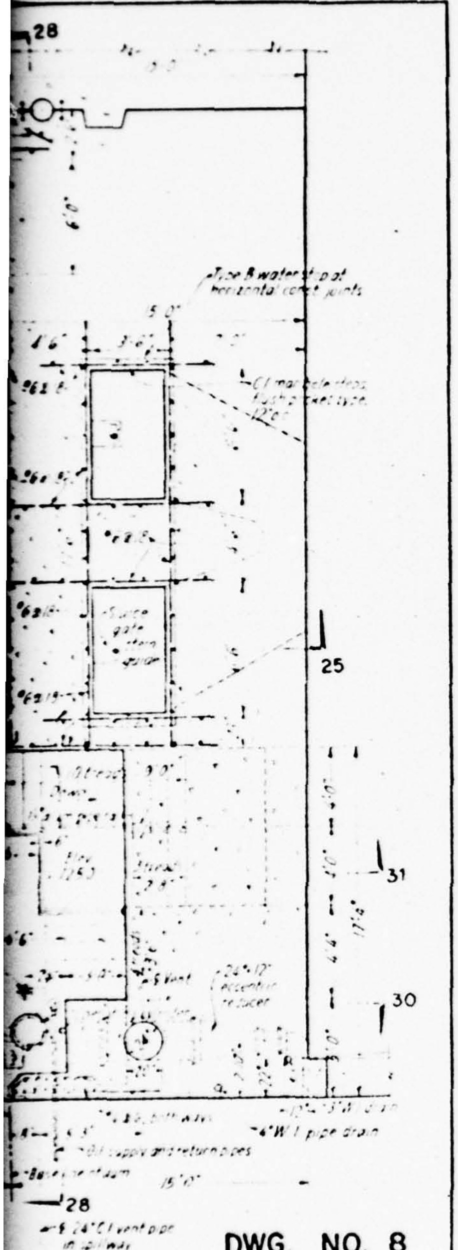
CHECKED

APPROVED

ISSUED

SCALE

ENGINEERS — PARSONS



DWG. NO. 8

AS BUILT

CITY OF NEWARK N.J.
PEQUANNOCK RIVER WATER SUPPLY

CHARLOTTEBURG RESERVOIR PROJECT
CONTRACT NO CRP-5

CHARLOTTEBURG DAM

INTAKE
SECTIONS AND DETAILS

SCALE AS SHOWN

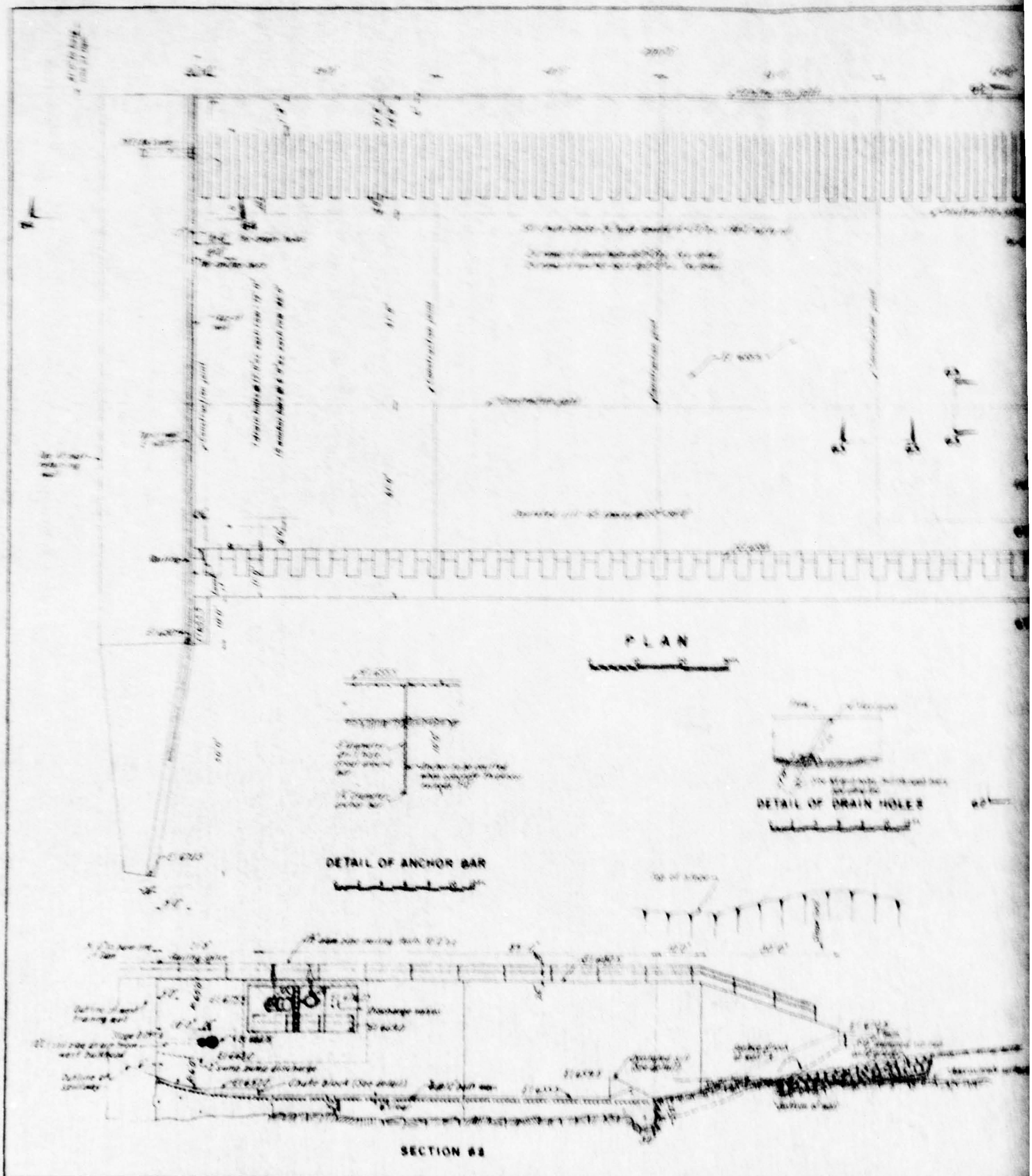
DWG NO 12 OF 31

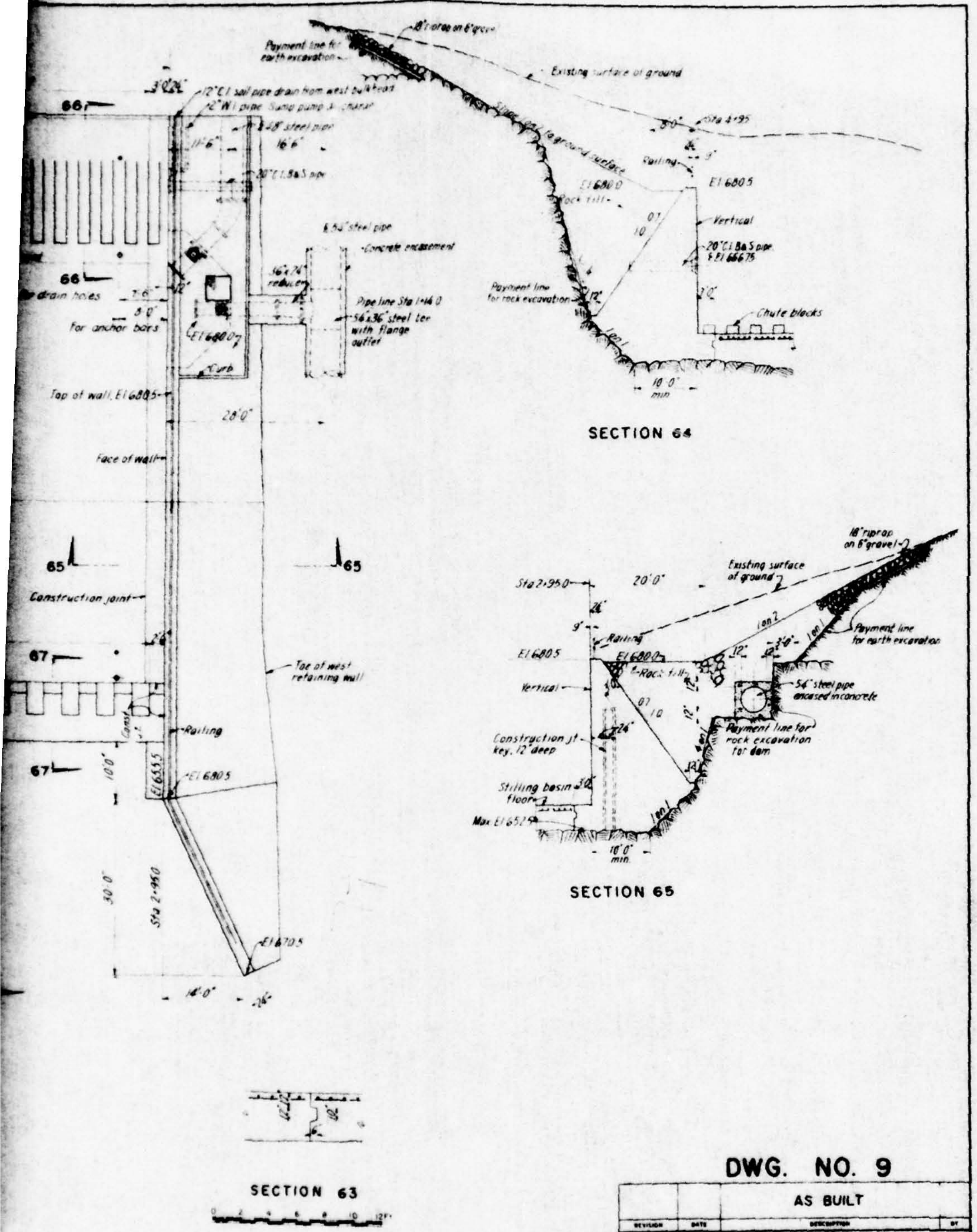
PARSONS BRINCKERHOFF HALL & MACDONALD
NEW YORK N.Y.

G. Gale Dixon
ASSOCIATE

File No 596—24-Sa-12

3


PLAN
DETAIL OF ANCHOR BAR
DETAIL OF DRAIN HOLES
SECTION #2



DWG. NO. 9

AS BUILT

REVISION	DATE	DESCRIPTION	BY

CITY OF NEWARK, N. J.

PEQUANNOCK RIVER WATER SUPPLY

CHARLOTTEBURG RESERVOIR PROJECT

CONTRACT NO. CRP-5

CHARLOTTEBURG DAM

STILLING BASIN

PLAN AND SECTIONS

DRAWN E.A.S. CHECKED C.A.H. APPROVED H.L.F.	ISSUED AUG 22, 1958 SCALE AS SHOWN	DWG NO. 17 OF 31

ENGINEERS PARSONS, BRINCKERHOFF, HALL & MACDONALD NEW YORK, N.Y.

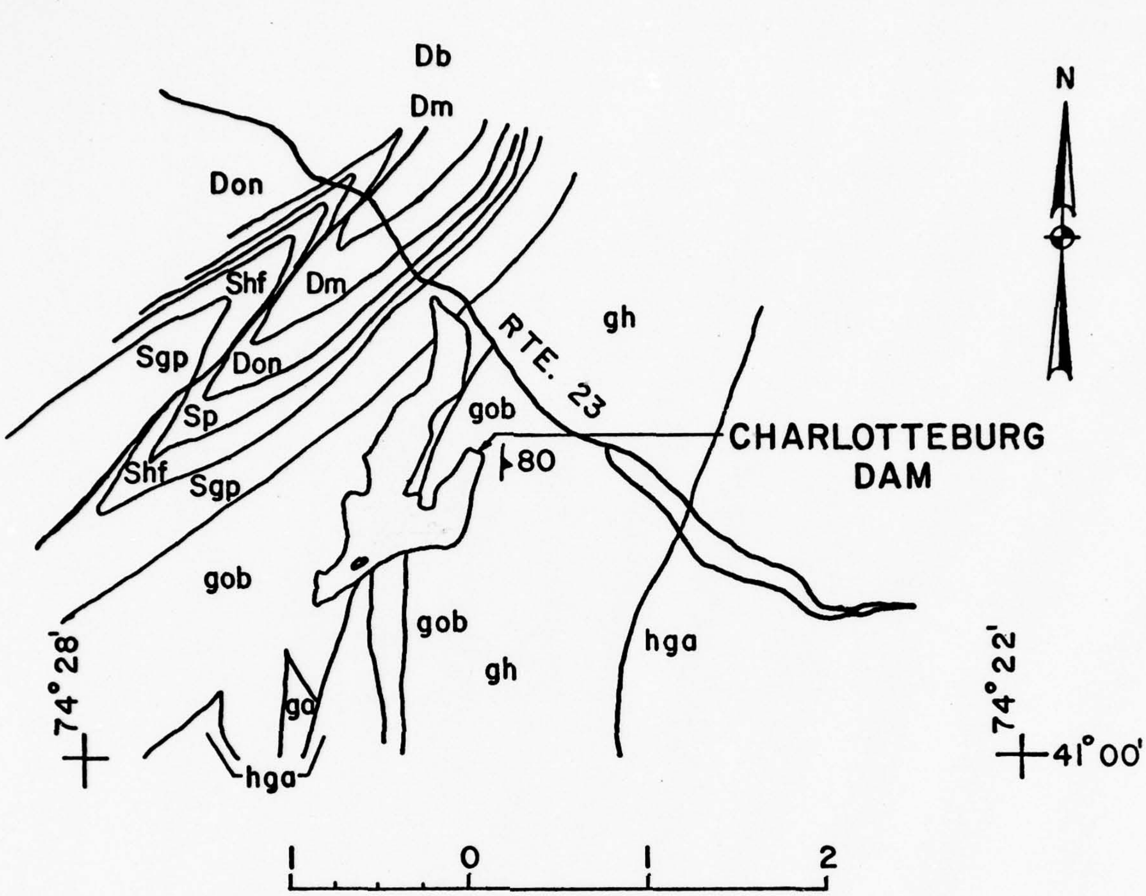
G. Gale Dixon ASSOCIATE

APPROVED FOR THE CITY OF NEWARK, N. J.

by ... DIVISION ENGINEER, DIVISION OF WATER SUPPLY DATE Feb. 14, 1958

DIRECTOR, DEPARTMENT OF PUBLIC WORKS DATE Feb. 14, 1958

3



Scale: 1" = 1 Mile

LEGEND:

	DEVONIAN		PRE-CAMBRIAN
Db	Bellvale Sandstone	gh	Hornblende Granite & Gneiss
Dm	Marcellus Shale	ga	Alaskite
Don	Onondaga Limestone	hga	Andesine Gneiss
	SILURIAN	gob	Biotite Gneiss
Sp	Poxono Island Formation (Shale)		
Shf	High Falls Formation (Sandstone and Shale)		
Sgp	Green Pond Conglomerate		

Contact

Fault, dashed where inferred

80 Strike and dip of foliation

GEOLOGIC MAP
CHARLOTTEBURG

DWG. NO. 10

APPENDIX A

CHECK LIST - VISUAL OBSERVATIONS

CHECK LIST - ENGINEERING, CONSTRUCTION
MAINTENANCE DATA

CHECK LIST
VISUAL INSPECTION
PHASE 1

Name Dam CHARLOTTEBURG DAM County Passaic State New Jersey Coordinators ______

Date(s) Inspection May 1, 1978 & May 6, 1978 Weather Sunny, Fair, Raining Temperature 50°F 55°F

Pool Elevation at Time of Inspection 741.5 M.S.L. Tailwater at Time of Inspection 664.75 M.S.L.

Inspection Personnel:

Robert Gershowitz, May 1	Yin Au-Yeung, May 1	Lynn Brown, May 6
Seymour Roth, May 1	William Flynn, May 1	Larry Woscyna, NJ-DEP, May 1
David Kerkes, May 1 and 6	Michael Jones, May 1	

Recorder: Seymour M. Roth

Owner: Newark Water Department - Representants: William Bostedo, Chief Water Plant Operator
John Deering, Assistant to Superintendent

On May 1, 1978 - 82 MGD were being drawn from reservoir for water treatment.
Water being drawn from intake opening at Elevation 725.
Top of bascule gate at Elevation 743.0 (fully closed).

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SEE PAGE ON LEAKAGE	Main Dam: No visible seepage on downstream side of main dam at toe. The toe is obscured by a rock gutter on top of backfill. Horizontal joint leakage observed in right abutment (East bulkhead), Monolith 11, at an approx. elevation 738; wetting of concrete considerable. River Wall: Joint leakage in vertical joints between monoliths observed in one or two locations approx. 200 ft. from easterly end of wall.	Main Dam: Monolith 11 leakage should be investigated further to determine source and path. River Wall: Joint leakage should be stopped.
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Apparently there is good contact and no visible leakage.	No action required.
DRAINS	Lower gallery drains in right abutment are draining at less than 5 gpm (est.). The majority of leakage appears to originate from the vertical joint, between monoliths 11 and 12, which is leaking water at a rate of 1-2 gpm (est.). The lower gallery drains in left abutment (West bulkhead) are not draining any water at all, and the gutters are dry.	No action required.
WATER PASSAGES	The water passages were not available for inspection in the dry because of design and operational considerations.	No action required.
FOUNDATIONS	The main dam is founded on granite and gneiss rock formations. The foundation has been grouted from the gallery at a spacing of 5 to 6-ft. centers upstream of the foundation drainage holes. An outcrop on the right abutment indicates that the foliation of the rocks strikes nearly due North and dips between 80° West and vertical. The river wall is founded on sands and gravels. The reservoir rim shows no signs of major instability problems.	No action required.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	There is light deterioration of the downstream face of the overflow and non-overflow monoliths of the main dam, some popping-off of concrete over large aggregate pieces locally. A poor lift joint was observed in spillway monolith 9 at an approx. elevation of 685-700 ft. where water has eroded the joint.	Repair is recommended.
	Spillway monolith 6 has a slight surface depreciation at elevation 695 to 700 ft. due to poor concrete placing or forming.	Not considered serious.
	All interior surfaces are considered fair to very good; the interior vertical monolith joints at the gallery are not chamfered or beveled and have cracked irregularly.	No action required.
STRUCTURAL CRACKING	None observed.	
VERTICAL & HORIZONTAL ALIGNMENT	Main Dam: All alignments seem very good.	
	River Wall: A slight horizontal misalignment in monoliths approx. 200 ft. from east end of river wall is visible when sighting along the top of the wall.	Cause for misalignment should be investigated further.
MONOLITH JOINTS	Main Dam: Majority of joints are tight. Monolith joint 11/12 leaks water at rate of 1-2 gpm.	This joint should be monitored to determine whether leakage is constant or stable.
	River Wall: Two vertical monolith joints were observed leaking at low head some 200 ft. from east end of wall.	Should be monitored
CONSTRUCTION JOINTS	Main Dam: Horizontal lift joint in monolith 11 at elevation 738 (approx.) is leaking water on downstream side; width 10 ft ±.	Should be monitored, investigated and/or corrected.
	There is general minor leakage into the upper gallery at the horizontal construction joint on the downstream side and formation of leakage mineralization on the surface of the walls below the leakage plane.	Not considered significant

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	NA	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	NA	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	NA	
VERTICAL & HORIZONTAL ALIGNMENT OF THE CREST	NA	
RIPRAP FAILURES	Riprap protection behind stilling basin walls and along both sides of outlet channel was in good condition.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	NA	
ANY NOTICEABLE SEEPAGE	NA	
STAFF GAGE AND RECORDER	NA	
DRAINS	NA	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CRACKING & SPALLING OF CONCRETE SURFACES IN STILLING BASIN	Stilling basin concrete is good on the side walls. The baffle blocks and end sill are not visible for inspection due to normal tailwater. The hollow cone discharge valve recess in the left stilling basin wall has concrete surfaces in good condition.	Recommend owner dewater and inspect stilling basin floor, check blocks and end sill at convenient time for his operations within one calendar year and file report with Corps of Engineers
INTAKE STRUCTURE	Upstream face has a generally good appearance above pool, elevation 741.50. Trash racks are in use and appear good. Stop logs and intake aperture permit drawing of water from any desired elevation; currently drawing 82 mgd from elevation 725.	No action required.
OUTLET CHAMBER IN DAM	Large vertical shaft in monolith 5 gives access to cone valve below. Some minor leakage from horizontal lift joints. Some leakage water on floor of cone valve chamber from valve operation. Sump pump in cone valve chamber not operating on 5/1/78.	No action required.
OUTLET FACILITIES	A 54-inch diameter raw water supply line is served by twin 48-inch diameter passes each with a 30-inch diameter cone valve and a 48-inch diameter emergency slide gate. A 48-inch diameter by-pass outlet is provided to dewater the dam, outletting in a 30-inch diameter hollow cone valve.	No action required. Repair lubricating oil leak in 30-inch diameter hollow cone valve.
EMERGENCY GATE	A 48 x 48 Broome gate is provided, complete with lifting beam for the two 48-inch diameter raw water discharge passes and the 48-inch dia. by-pass line. The gate is stored on the floor at elevation 750.5. Gate is in excellent condition.	No action required.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE WEIR	NA	
APPROACH CHANNEL	NA	
DISCHARGE CHANNEL	NA	
BRIDGE AND PIERS	NA	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE SILL	Ogee sill is in good to excellent condition, well finished, and showing very little freeze thaw deterioration.	
APPROACH CHANNEL	NA	
DISCHARGE CHANNEL	No bank erosion. Stable channel.	
BRIDGE AND PIERS	NA	
GATES AND OPERATION EQUIPMENT	Bascule gate, Allis Chalmers, 200-ft. long by 5-ft high, crest at elevation 738, top of gate at elevation 743. Gate automatically maintains pool level at 743.3±. Hydraulic operating equipment generally good, but right operating cylinder has experienced severe hydraulic fluid leak and will be replaced. Bascule gate has general rust over 10 percent of area. Leakage from bascule gate is considerable on Monoliths 8 & 9; less on Monolith 7 and very little on Monolith 6.	Repair pool elevation recorder; repair packing on right hydraulic cylinder. Bascule gate should be repainted. On normal maintenance cycle. investigate reasons for gate leakage and correct. Leakage is considered not serious.

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
MONUMENTATION/ SURVEYS	None observed	
OBSERVATION WELLS	None observed	
WEIRS	None	
PIEZOMETERS	None	
OTHER	No firm figure available on discharge over spillway due to automatic gate operation. Spillage could be calculated if gate position were to be recorded manually or automatically. Gage downstream at Macopin Dam records stream discharge on greater drainage area.	Suggest recording of gate position and discharge over spillway.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENTATIONS
SLOPES	Slopes on reservoir rim mild to moderately steep, no appatent sloughing or slumping evident. Rim of reservoir is lightly vegetated with deciduous trees. There is a slight soil cover over predominantly competent rock formations. A clearly identifiable high water line can be seen at elevation 743.50 $\pm$ 0.25.	No action required.
SEDIMENTATION	Alleged to be light due to presence of upstream reservoirs (Canistear, Echo Lake, Clinton and Oak Ridge reservoirs).	No action required.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	There is a well defined channel and overbank valley for 1,000 feet downstream of the dam. Channel has a stony bottom. There are no signs of erosion or undercutting.	No action required.
SLOPES	Moderate to steep, covered by solid vegetative, grassy and wooded. No recent damage evident.	No action required
APPROXIMATE NUMBER OF HOMES AND POPULATION	Access to the dam is above flood stage. There is one high level dam access bridge approximately 1,000 feet downstream of dam. A screening chamber facility exists 1,500 feet downstream of the dam, with a large chlorination and aeration facility 2,000 feet downstream. No homes in immediate downstream reach.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Available for main dam and river wall.
REGIONAL VICINITY MAP	Available
CONSTRUCTION HISTORY	Dam built and operating by 1961. Some inspection reports on the foundation in N.J. Department of Environmental Protection files.
TYPICAL SECTIONS OF DAM	Available
HYDROLOGIC/HYDRAULIC DATA	Pool levels being recorded daily. Local rainfall data available. Flow data (USGS gage) prior to construction on Pequannock River at Macopin Dam available; flow records after construction also available. Rating curve at dam site prior to construction available.
OUTLETS - PLAN	) Complete outlet plans available.
- DETAILS	)
- CONSTRAINTS	)
- DISCHARGE RATINGS	)
RAINFALL / RESERVOIR RECORDS	Same as above under Hydrologic/Hydraulic Data.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
DESIGN REPORTS	Hydrology report available for determination of Spillway Design Flood.
GEOLOGY REPORTS	Geologic boring logs at dam available as part of contract documents.
DESIGN COMPUTATIONS	No design computations uncovered.
HYDROLOGY & HYDRAULICS	Hydrologic design memorandum on project available.
DAM STABILITY	Stability analysis summary for main dam available.
SEEPAGE STUDIES	No seepage studies available.
MATERIALS INVESTIGATIONS	Boring records available.
BORING RECORDS	
LABORATORY	
FIELD	
POST-CONSTRUCTION SURVEYS OF DAM	None uncovered.
BORROW SOURCES	No data uncovered.
SPILLWAY PLAN - SECTIONS	Complete as-built contract plans available.
- DETAILS	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
OPERATING EQUIPMENT PLANS AND DETAILS	Complete as-built contract plans available.
MONITORING SYSTEMS	None installed.
MODIFICATIONS	None
HIGH POOL RECORDS	Daily pool elevation records available from 1961 on.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None uncovered
PRIOR ACCIDENTS OF FAILURE OF DAM - DESCRIPTION - REPORTS	None reported.
MAINTENANCE OPERATION RECORDS	Manual for maintenance of Allis Chalmers bascule gate available.

APPENDIX B

PHOTOGRAPHS

PHOTOGRAPHS TAKEN DURING MAY 1978

Photo 1 - View of spillway and bascule crest gate looking toward right abutment

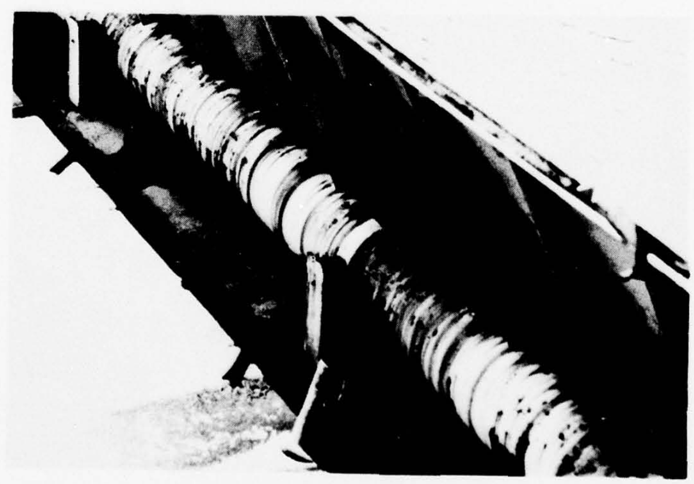


Photo 2 - Close-up of bascule crest gate in fully closed position

Photo 3 - Stilling basin and right stilling basin wall

Photo 4 - Downstream end of right stilling basin wall; end sill and baffle blocks are submerged by normal tailwater

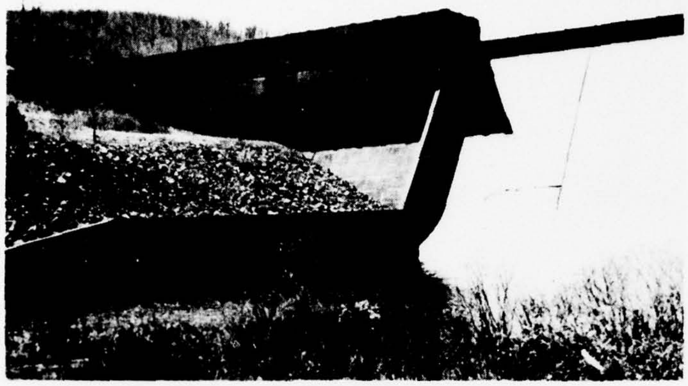


Photo 5 - Spillway, right abutment and right stilling basin retaining wall. Note wet spot on downstream face of non-overflow monoliths indicating poor lift joint

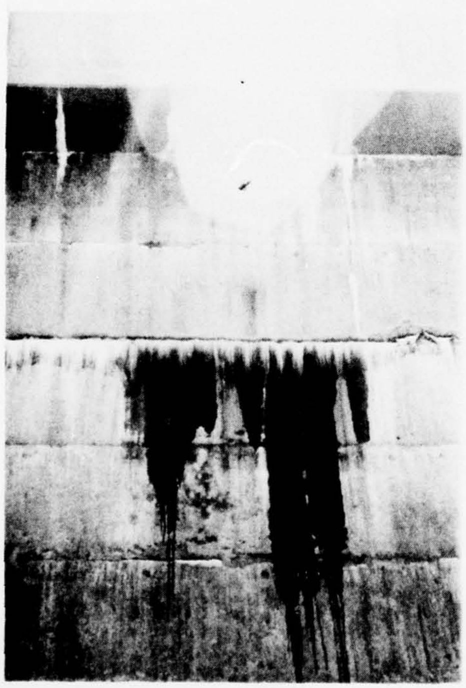


Photo 6 - Close-up of wet spot on monolith 11 indicating leakage through bad horizontal lift joint

AD-A058 155 HARRIS ECI ASSOCIATES WOODBRIDGE NJ F/G 13/2
NATIONAL DAM SAFETY PROGRAM. CHARLOTTEBURG DAM (NJ00316). PASSA--ETC(U)
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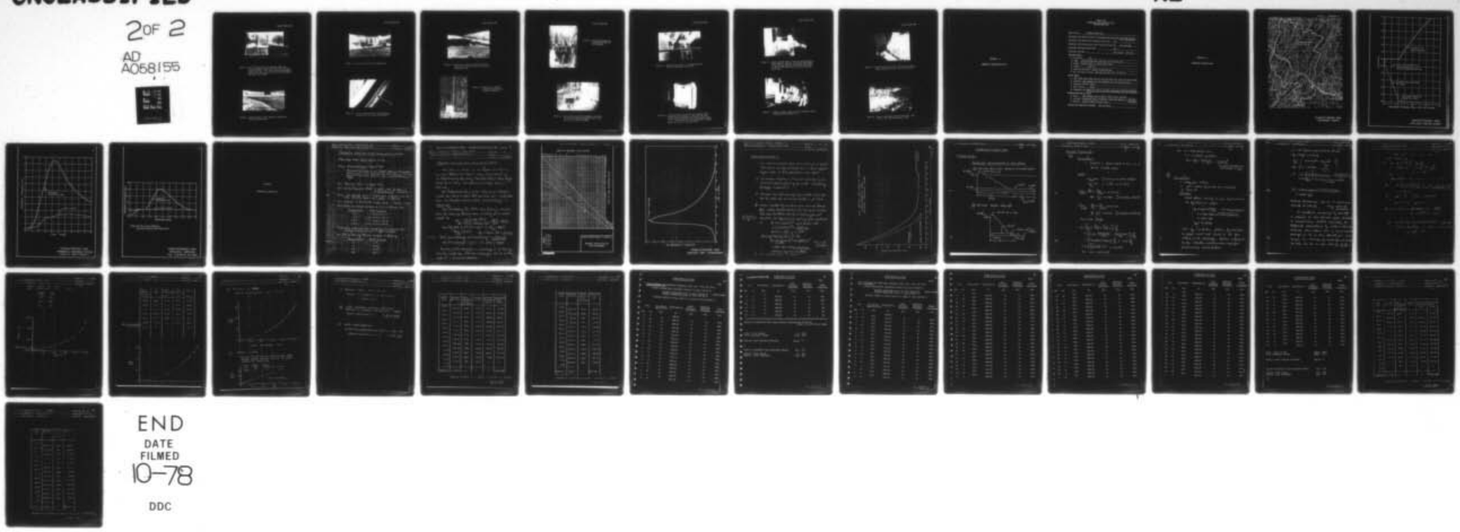

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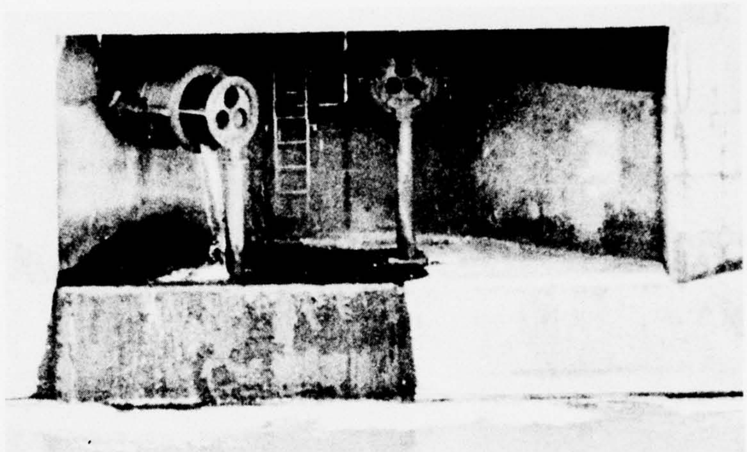


Photo 7 - Left stilling basin wall showing recess for 30-inch diameter hollow cone valve from 48-inch diameter by-pass line (left) and 24-inch diameter hollow cone valve for draining of 54-inch diameter raw water line (right)

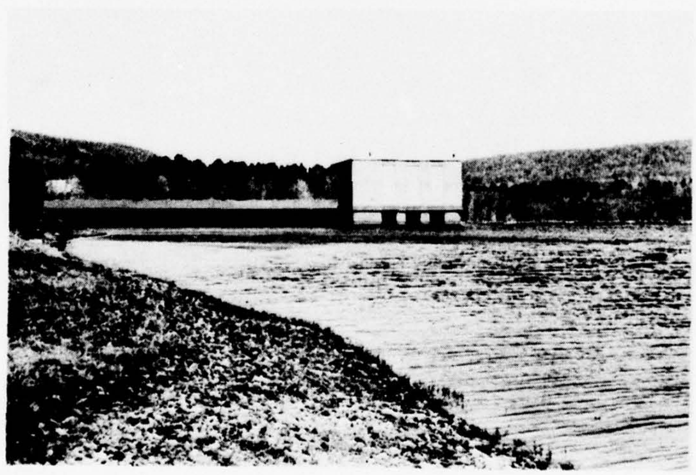


Photo 8 - Upstream view of left abutment, showing the Intake and Gate House

Photo 9 - General view of dam from downstream

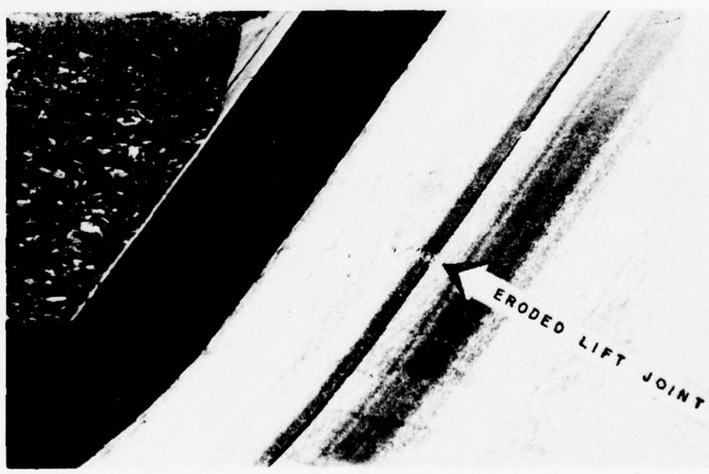


Photo 10 - Spillway looking toward right abutment
showing poor lift joint in monolith 9

Photo 11 - River Wall - General view of River Wall looking upstream and north-west along the Pequannock River

Photo 12 - River Wall - Leaking vertical monolith joint at base of monolith

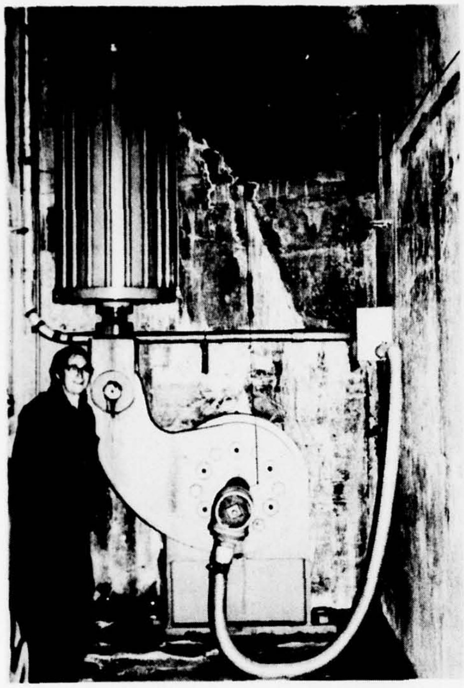


Photo 13 - Spillway bascule gate actuating cylinder on left abutment

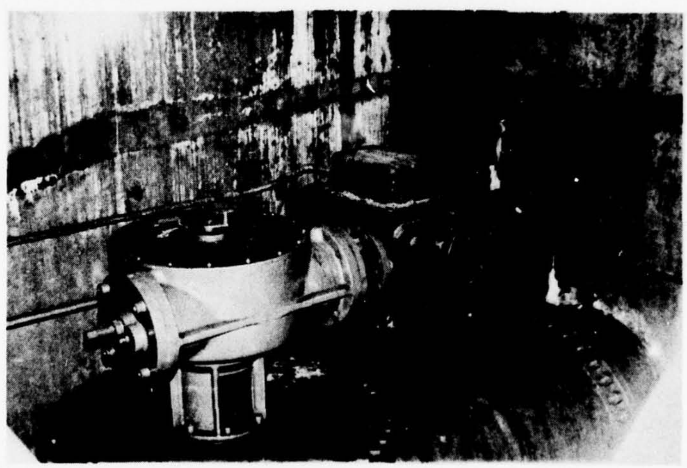


Photo 14 - Valve shaft and 30-inch diameter cone valve on right side 48-inch diameter pass of raw water line; looking upstream

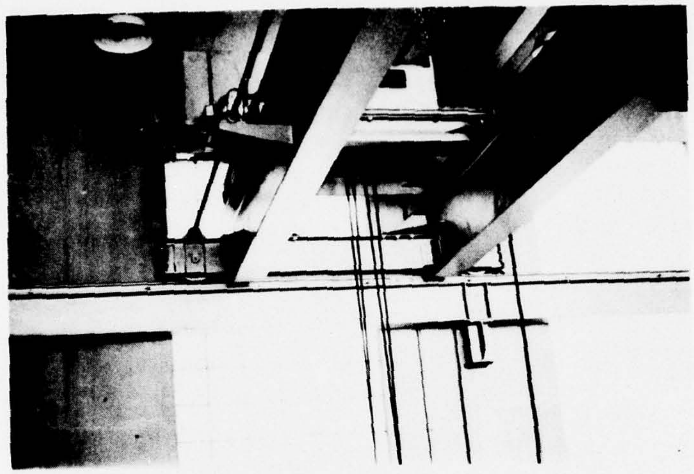


Photo 15 - Intake and Gate House - Overhead crane for lifting of emergency Broome Gate

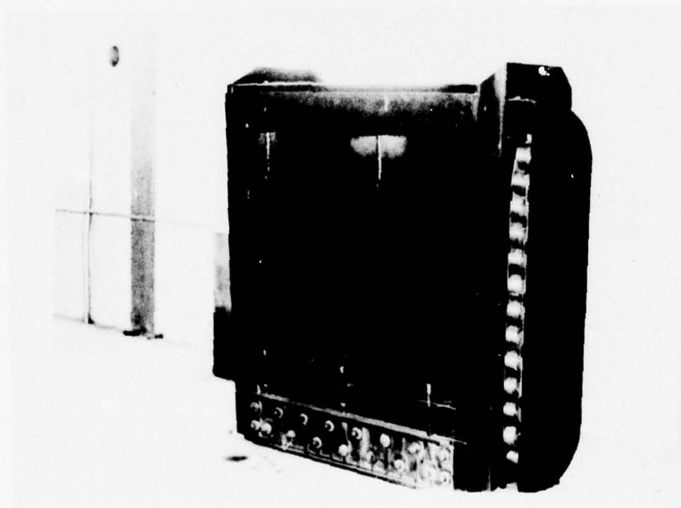


Photo 16 - Intake and Gate House-Floor at Elevation 750.5, Broome gate for emergency closure of the twin 48-inch raw water passes and the 48-inch by-pass line. Lifting beam for the Broome gate is stored below the floor at elevation 750.5.

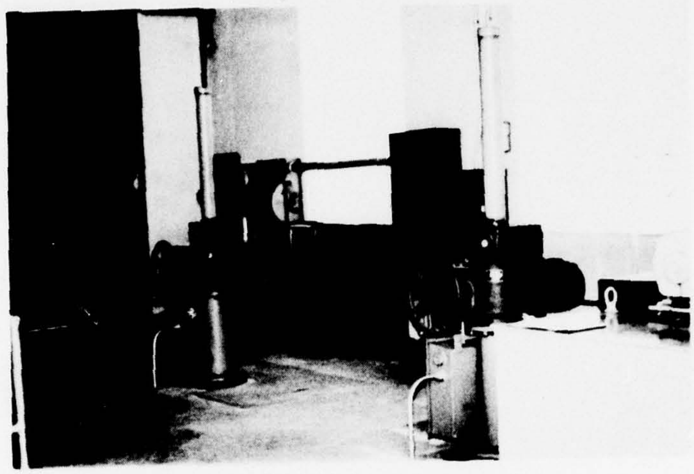


Photo 17 - Intake and Gate House - Floor at elevation 750.5, Motor operated 48-inch slide gates downstream of the 30-inch diameter cone valves for closure of the twin 48-inch passes of the 54-inch raw water line

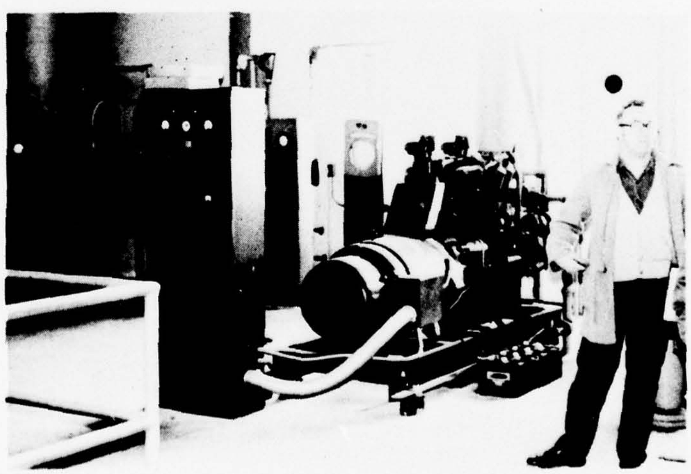


Photo 18 - Intake and Gate House - Floor at elevation 750.5, Emergency motor generator set

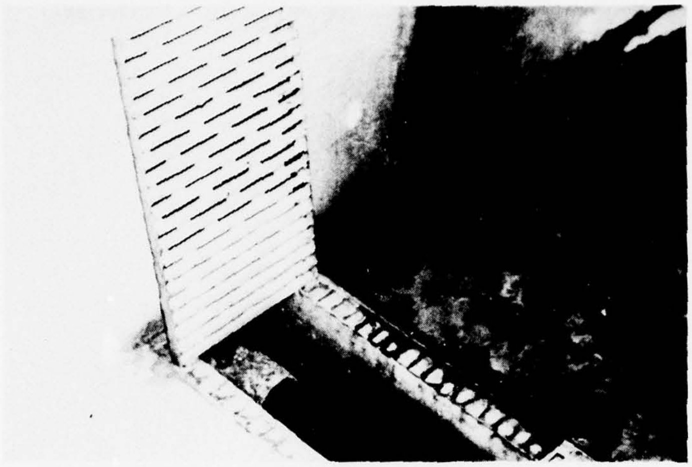


Photo 19 - Lower Inspection Gallery - Typical joint drain; looking upstream at joint (to left of drain)

Photo 20 - View of downstream channel below dam; stony invert, well defined overbank valley

APPENDIX C

SUMMARY OF ENGINEERING DATA

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

Name of Dam: CHARLOTTEBURG DAM

Drainage Area Characteristics: On Pequannock River with drainage area of 56.3 square miles

Elevation Top Normal Pool (Storage Capacity): 743

Elevation Top Flood Control Pool (Storage Capacity): Not provided

Elevation Maximum Design Pool: 748

Elevation Top Dam: 750 (Length = 675 ft.)

SPILLWAY CREST:

a. Elevation 138

b. Type Concrete overflow, ogee weir with bascule gate

c. Width Bascule gate is 5 feet total width

d. Length 200 ft.

e. Location Spillover Center of gravity dam

f. No. and Type of Gates One bascule gate 5 ft. by 200 ft.

OUTLET WORK:

a. Type 48"Ø steel pipe blow off and one 54"Ø steel pipe for water supply

b. Location Gate chamber on left abutment next to spillway crest

c. Entrance Inverts 675.0

d. Exit Inverts 674.0

e. Emergency Draindown Facilities 48-inch steel pipe blow-off line with 30-inch hollow cone valve discharging into stillingbasin

HYDROMETEOROLOGICAL GAGES:

a. Type USGS gaging station 3825.0 Water level recorder

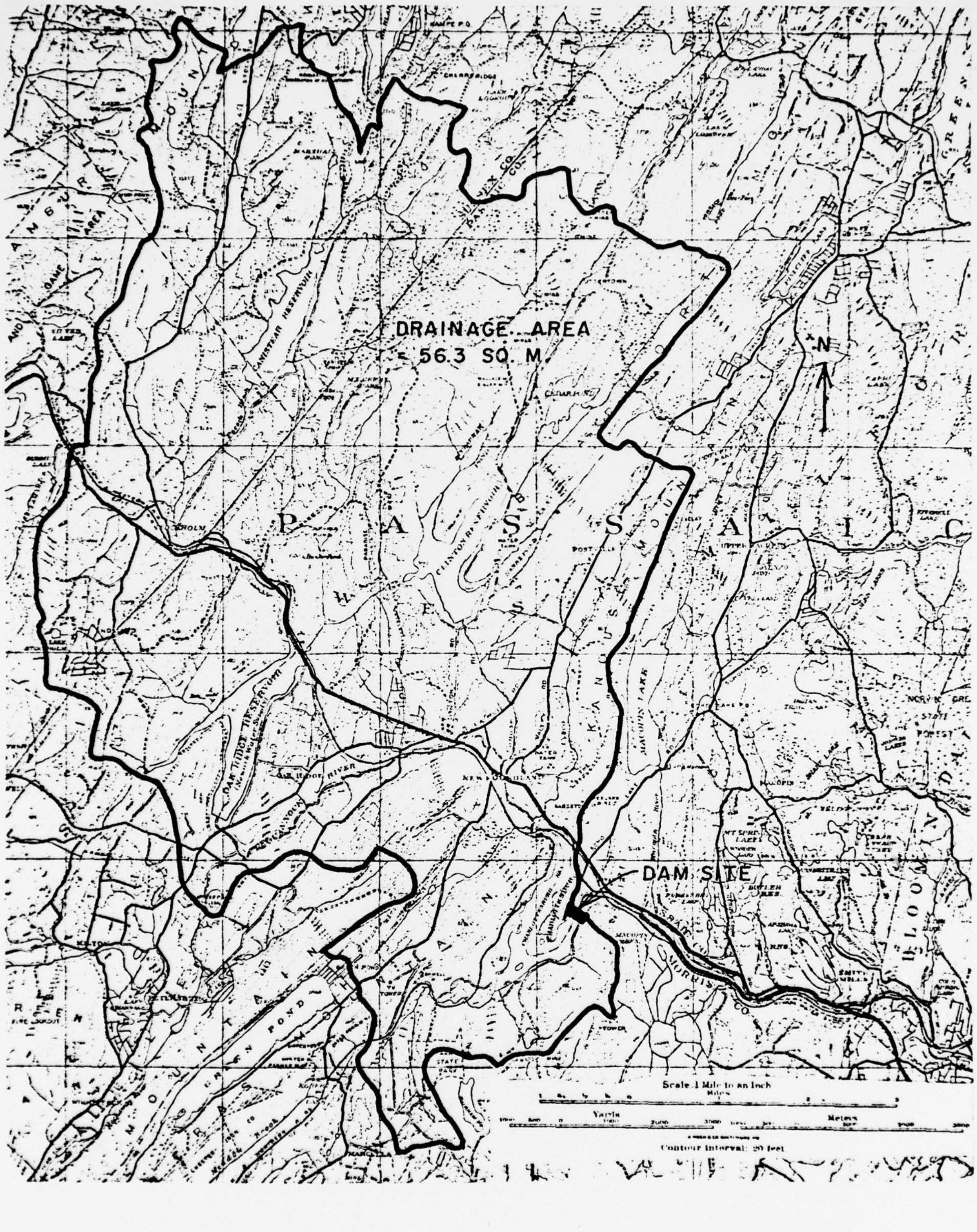
b. Location Pequannock River at Macopin Intake Dam (8000 ft. from Charlotteburg

c. Records January 1898 to current year

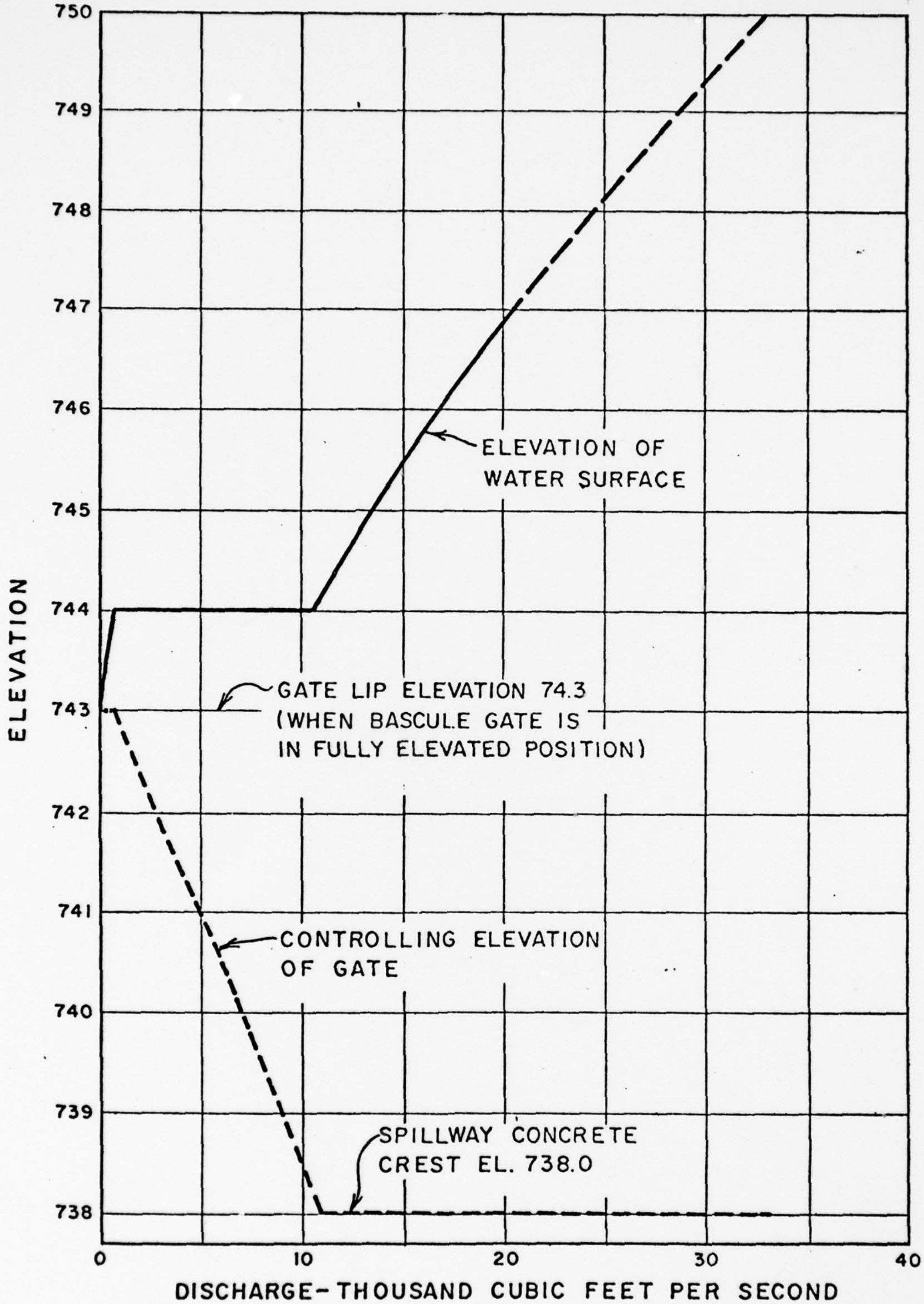
MAXIMUM NON-DAMAGING DISCHARGE Not available

APPENDIX D

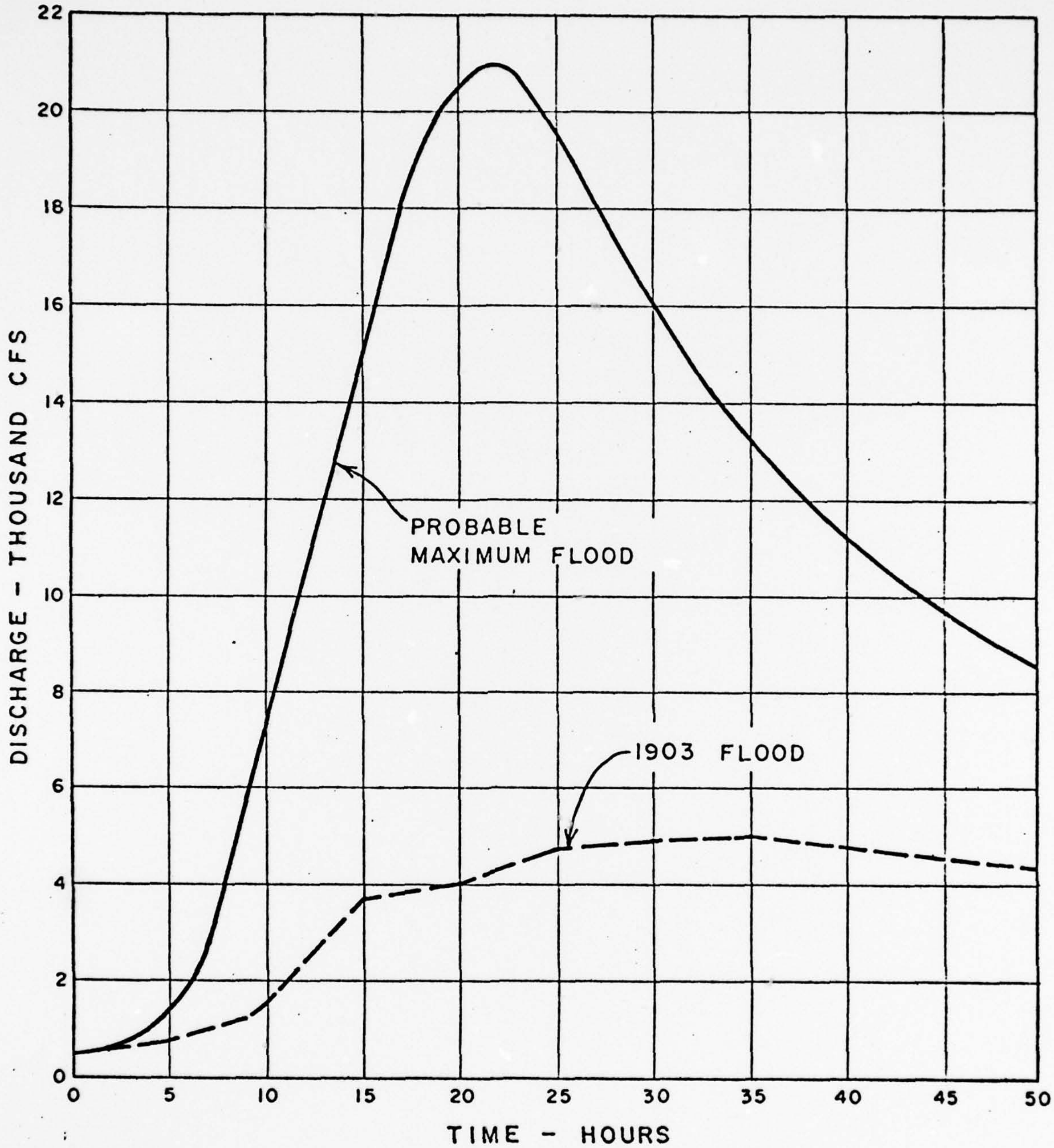
HYDROLOGIC COMPUTATIONS



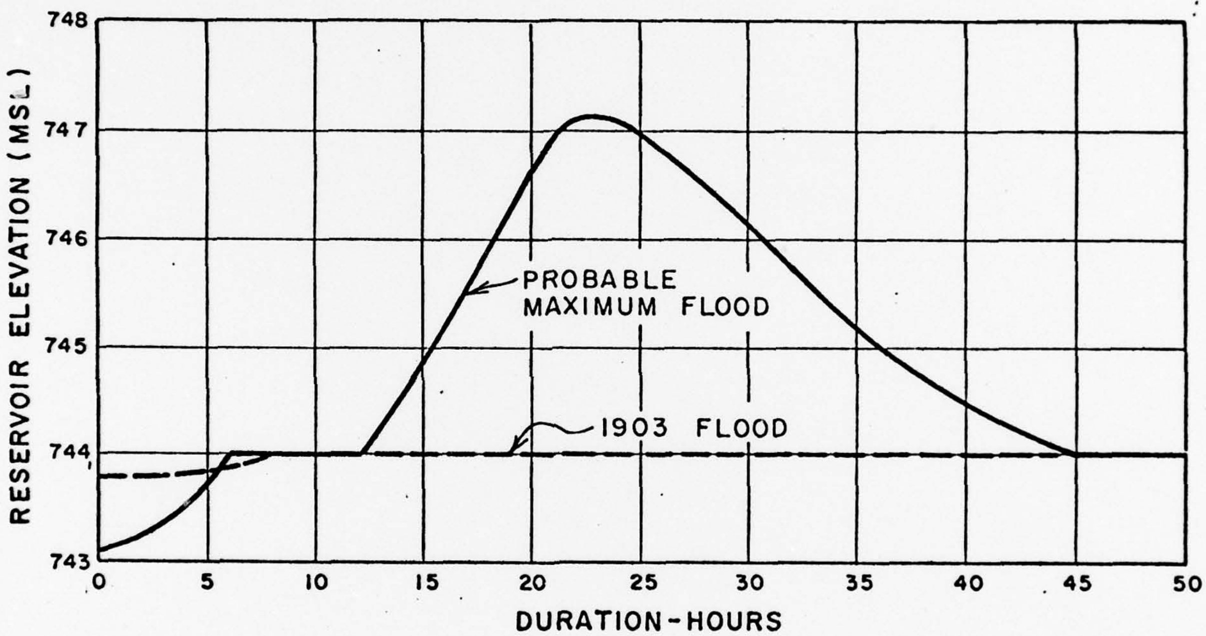
CHARLOTTEBURG DAM
DRAINAGE BASIN



CHARLOTTEBURG DAM
SPILLWAY RATING CURVE



CHARLOTTEBURG DAM
PROBABLE MAXIMUM FLOOD
(USED IN 1958 REPORT)



NOTE: PMP Given in the 1958 report
was used as Reservoir Inflow Design Flood

CHARLOTTEBURG DAM
SPILLWAY ROUTING
(W.S. ELEVATION VS TIME)

APPENDIX

HYDROLOGIC COMPUTATION

PROBABLE MAXIMUM FLOOD CALCULATION (PMF)

Drainage Area = 56.3 square miles.

From Hydrometeorological Report #33

" Seasonal Variation of the Probable Maximum Precipitation East of the 105 th Meridian for Areas from 10 to 1,000 square Miles and Duration of 6, 12, 24 and 48 Hours" 1956.

For Drainage Area 10 square Miles

The 6 Hour duration PMP is 24.5 inches for Zone 6 at Charlotteburg watershed.

Since the drainage area is larger than 10 square miles, an area reduction factor of 0.86 is applied.

The reduced 6 Hour PMP is 0.86 × 24.5 = 21.07 inches.

PMP values for rainfall durations of 6, 12, 24, 48 hours are:

Duration (Hrs)	PMP (inches)
6 Hr	1 × 21.07 = 21.07
12 Hr	1.09 × 21.07 = 23.00
24 Hr	1.17 × 21.07 = 24.65
48 Hr	1.34 × 21.07 = 28.23

PMP values shown above are reduced by 15 % to account for misalignment of basin and rainfall isohyetals.

The PMP for deriving PMF are therefore as following:

Duration (Hrs)	PMP (inches)
6	17.91
12	19.55
24	20.95
48	24.00

PROBABLE MAXIMUM FLOOD CALCULATION (PMF).

This dam is located on the Pequannock River. From the "Passaic River Report - Volume II Appendices" by the Department of the Army, New York District, Corps of Engineers dated June 1972, the following hydrologic data are obtained:

For Pequannock River at the location of the Macopin Intake dam which is about 800' downstream from the Charlotteburg dam, the Probable maximum flood peak discharge is 16300 cfs.

The Charlotteburg Dam PMF peak discharge compute from the ratio of drainage area according to the above report is.

$$A_1/A_2 = \frac{\text{D.A. for Charlotteburg}}{\text{D.A. for Macopin Intake}} = \frac{56.3}{63.7} = 88.4\%.$$

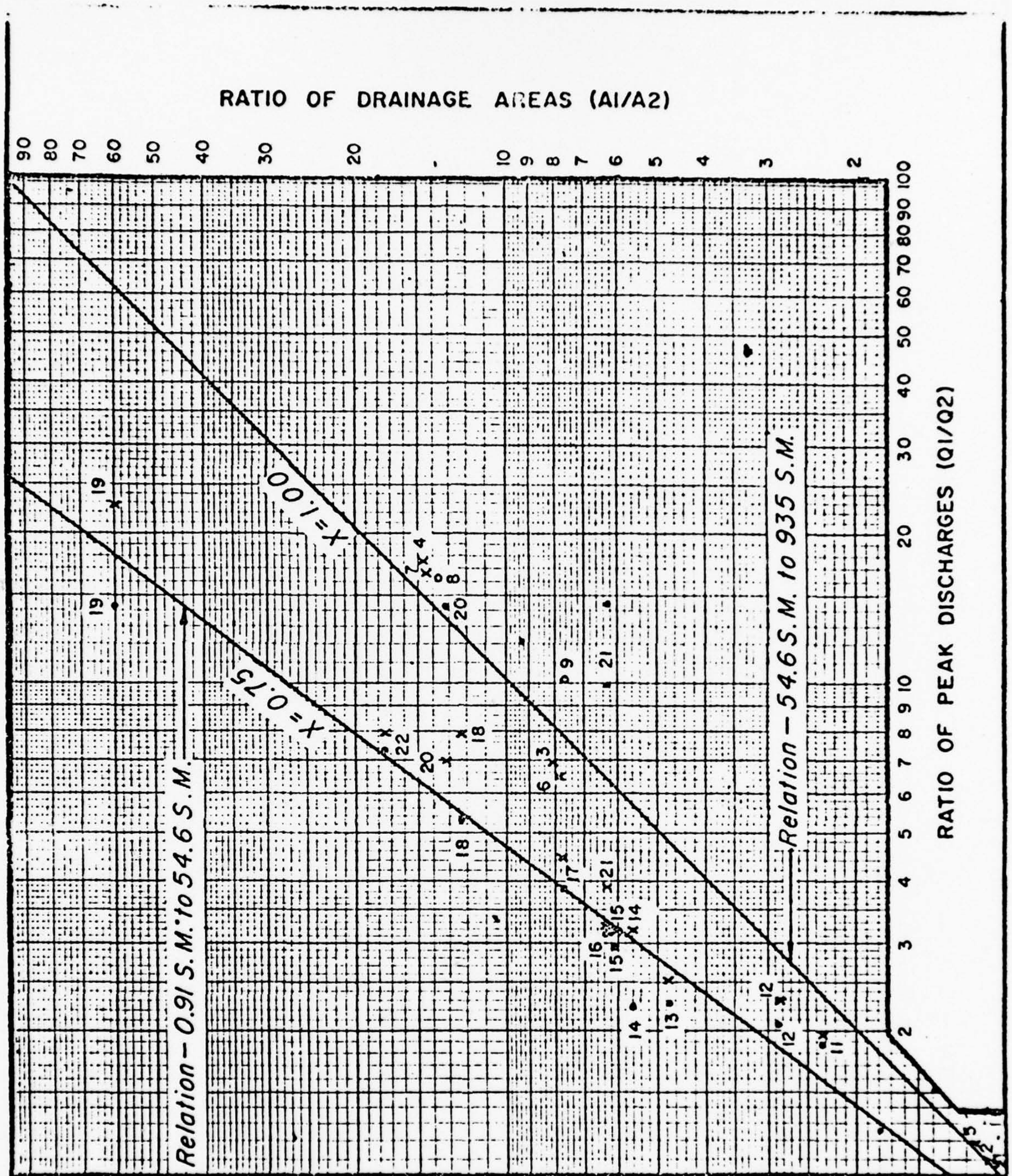
From Fig. A26 of the same report for $A_1/A_2 = 88.4\%$

$Q_1/Q_2 = 91.5\%$ $\therefore Q_1 = 16300 \times .915 = 14900$ cfs

∴ PMF peak Discharge at Charlotteburg is 14900 cfs

The PMF hydrograph is given in the following Pages.

Routing of PMF hydrograph is unnecessary if the spillway capacity exceeds the PMF peak discharge, and the spillway capacity is considered adequate.

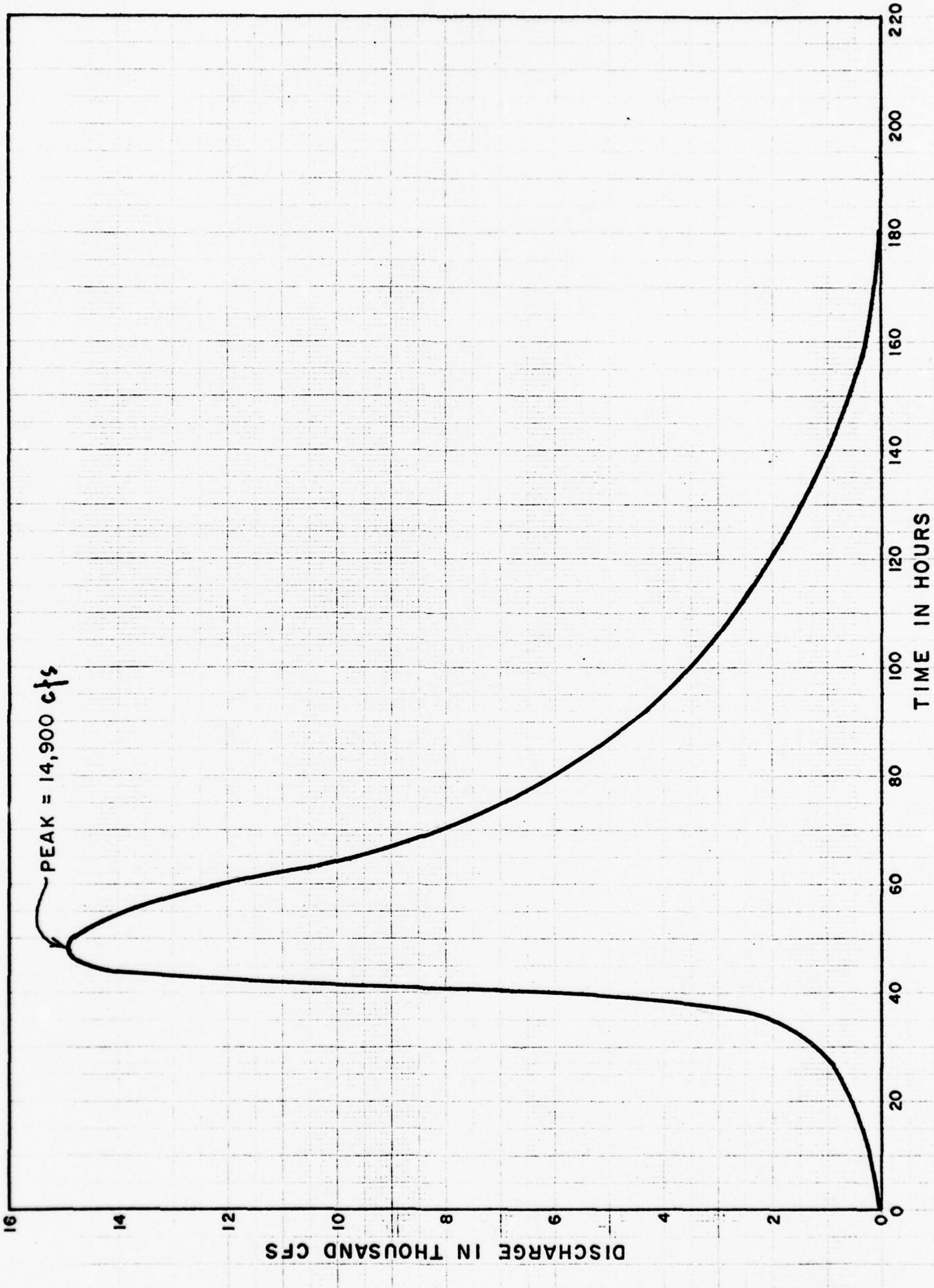


LEGEND

X Oct. 1903 Flood
• July 1945 Flood
o Oct. 1955 Flood

PASSAIC RIVER BASIN, N. J. AND N. Y.

DRAINAGE AREA RATIOS VS PEAK DISCHARGES



CHARLOTTEBURG DAM
DERIVED PMF - HYDROGRAPH

CHECK SPILLWAY CAPACITY.

1. The maximum probable flood peak discharge of 21,100 cfs was used in the original design which is about 1.41 times higher than the PMF calculated in this report.

2. The reservoir elevation is at elevation 747.1 during the maximum probable flood of 21,100 cfs. (the spillway discharge is 20500 cfs)

3. Therefore the spillway capacity exceeds 14,900 cfs. for Q = 14,900 cfs the reservoir elevation is at 745.5.

4. Assume an extremely conservative case when the Bascule gate in fully elevated position with the lip at elevation 743 when the PMF hits and the Bascule gate not operable. The capacity of the spillway above elevation 743 is.

and surcharge storage = 0!

$Q = 3.4 (200)(h)^{1.5}$, up to elevation 750.
$= 3.4 (200)(7)^{1.5} = \underline{12595 \text{ cfs}}$.
which is $\underline{85\%}$ of the PMF.

Spillway Capacity above el. 750.

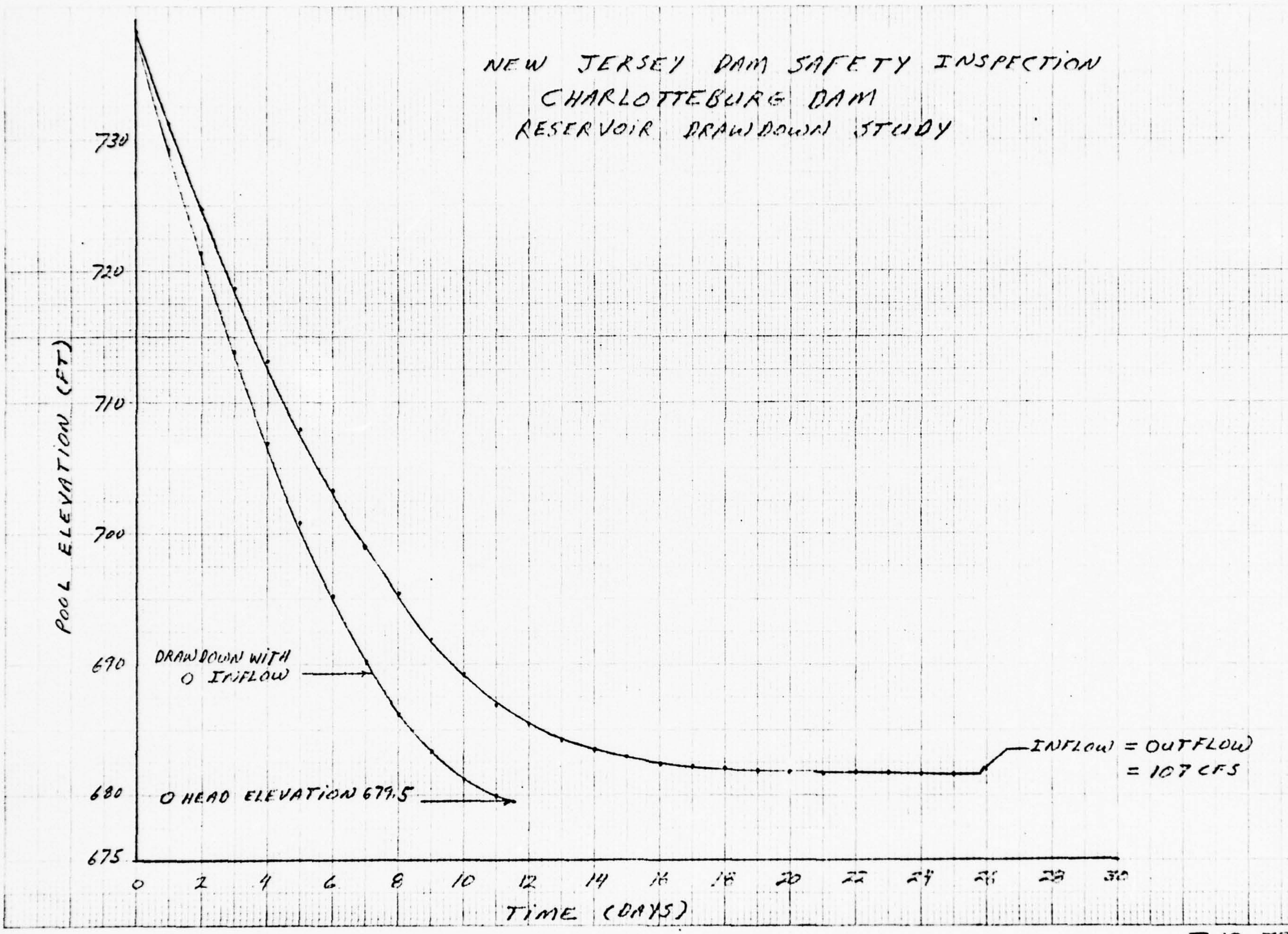
$Q = 3.4 (200)(h)^{1.5} + 3.0(475)(h)^{1.5} + 12595$

$= 763 + 1577 + 12595 = \underline{14925 \text{ cfs}}$.

Say h = .25' at el. 750.25

which is equal to the PMF.

5. The spillway capacity is adequate



NEW JERSEY DAM SAFETY INSPECTION
CHARLOTTEBURG DAM
RESERVOIR DRAWDOWN STUDY
POOL ELEVATION (FT)
730
720
710
700
690
680
675
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
TIME (DAYS)
DRAWDOWN WITH
0 INFLOW
0 HEAD ELEVATION 679.5
INFLOW = OUTFLOW
= 107 CFS

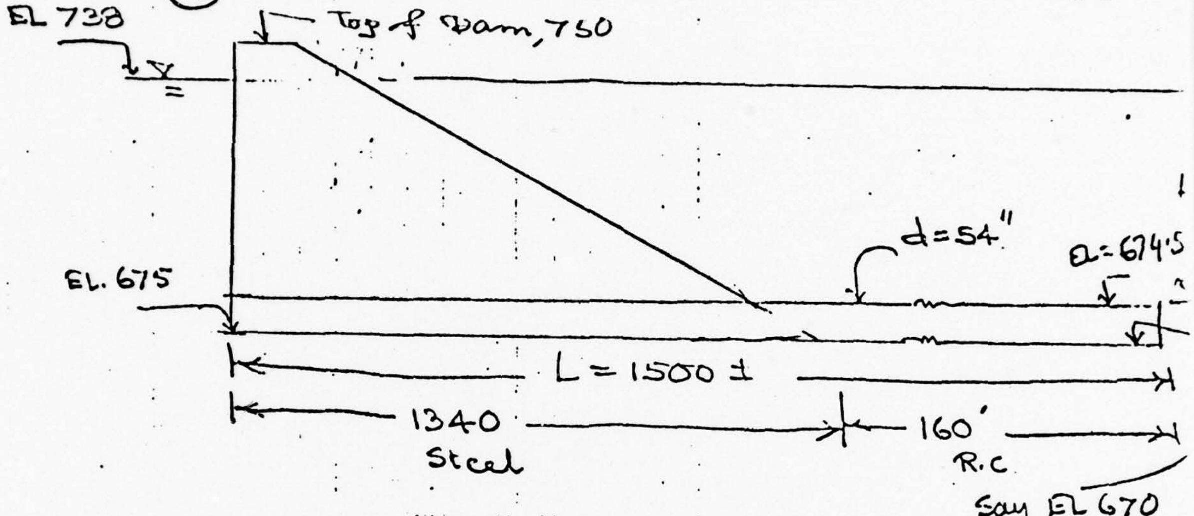
7-19-78

CHARLOTTEBURG DAM

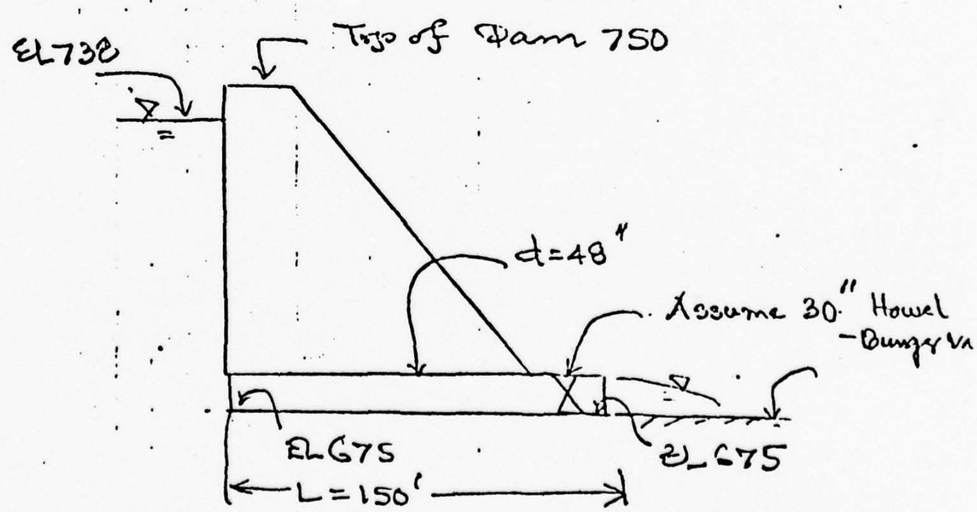
Outlet Works :

Assumed dimensions & Elevations

(A) 54 inch diameter Steel & Concrete pipe



(B) 48 inch Steel blow off



Outlet Capacity :

(A)

Assumptions :

1. Outlet is submerged & W.L. is at top of outlet pipe

Sol^n :

$\epsilon_{steel} = .03$ (assuming riveted steel).

$\epsilon_{conc} = .01$ (rough concrete)

Steel Pipe $\frac{\epsilon_s}{D} = \frac{.03}{54/12} = 0.0067$

$\Rightarrow f_s = 0.0325$ (Complete turbulence

Conc pipe $\frac{\epsilon_c}{D} = \frac{.01}{54/12} = 0.0022$

$\Rightarrow f_c = 0.025$ (Complete turbulence)

$K_e = 0.5$ (Say)

$$\therefore H = \left[K_e + \frac{f_c L_c}{D} + \frac{f_s L_s}{D} + 1\right]\frac{V^2}{2g}$$

$$= \left[0.5 + \frac{0.025 \times 160}{4.5} + \frac{.0325 \times 1340}{4.5} + 1\right]\frac{V^2}{2g}$$

$$= \left[0.5 + 0.89 + 9.68 + 1\right]\frac{V^2}{2g} = 12.07\,\frac{V^2}{2g}$$

$$V = \sqrt{\frac{1}{12.07}}\sqrt{2g}\,H^{1/2} = 2.31\sqrt{H}$$

$$Q = AV = 36.72\sqrt{H}$$

For $H = 738 - 674.5 = 63.5$

$$V = 2.31\sqrt{63.5} = 18.41 \text{ ft/sec}$$

$$Re = \frac{VD}{\nu} = \frac{18.41 \times 4.5}{10^{-5}} = \underline{8.28 \times 10^6}$$

Complete turbulence assumption is O.K.

(E)

Assumptions:

1. Fully open valve
2. 30" valve (measured from drawing)
3. $K_e = .5$

Solution

First obtain velocity in pipe by assuming no friction in pipe

$$\therefore Q = 0.85 A\sqrt{2gH} \quad \text{For Howell-Bunger Va}$$

$$= 0.85 \times .785 \times 2.5^2 \sqrt{64.4(738-675)}$$

$$= 266 \text{ cfs}$$

$$V_{48''} = 21 \text{ ft/sec}$$

With $V_{48''} = 21$ ft/sec, Obtain friction loss in pipe and net head H at the valve and discharge, further refinement of the solution will be unnecessary for preliminary calculation

$\epsilon = .03$ (assuming riveted steel)

$\therefore \frac{\epsilon}{D} = \frac{0.03}{4} = 0.0075$

$\frac{VD}{\nu} = 21 \times 4 \times 10^5 = 8.4 \times 10^6$

$\Rightarrow f = 0.00345$

$\therefore H = H_T - h_f - K_e \frac{V^2}{2g} = (738 - 675) - \frac{.00345 \times 150}{4} \times \frac{[illegible]}{[illegible]}$
$+ .5 \times \frac{21^2}{64.4} = 63 - 8.86 - 3.42 = 50.72$

$\therefore Q = 0.85 \times .785 \times 2.5^2 \sqrt{64.4 \times 50.72}$
$= 238$ cfs

Actual discharge will be in between 266 cfs & 238 cfs, Say 240 cfs.

A constant discharge of 240 cfs is added to the 54-inch pipe discharge to determine outlet capacity at different elevations of water surface behind the dam. This is done because change in Q in the blow off for the range in change of head (from El. 738 to El. 750) will be on the order of 20 cfs.

FOR 48" STEEL BLOW OFF

FOR ELEV. 708

1) $$H = H_T - f\frac{L}{D}\frac{V^2}{2g} - K_e\frac{V^2}{2g}$$
$$= (708-675) - \frac{.00345\times150}{4}\times\frac{V^2}{64.4} + .5\,\frac{V^2}{64.4}$$

Approximate V, assume no friction

2) $$Q = 0.85\,A\sqrt{2gH}$$ for Howell-Bunger Valve
$$= 0.85 \times .785 \times 2.5^2 \times \sqrt{64.4 \times (708-675)}$$
$$= 192 \text{ cfs}$$

3) $$V_{48"} = \frac{Q}{A} = \frac{192}{\pi\cdot 2^2} = 15.28 \text{ fps}$$

Replace V in equation 1

4) $$H = (708-675) - \left(\frac{0.00345\times150}{4}\times\frac{15.28^2}{64.4} + .5\,\frac{15.28^2}{64.4}\right) = 30.72$$

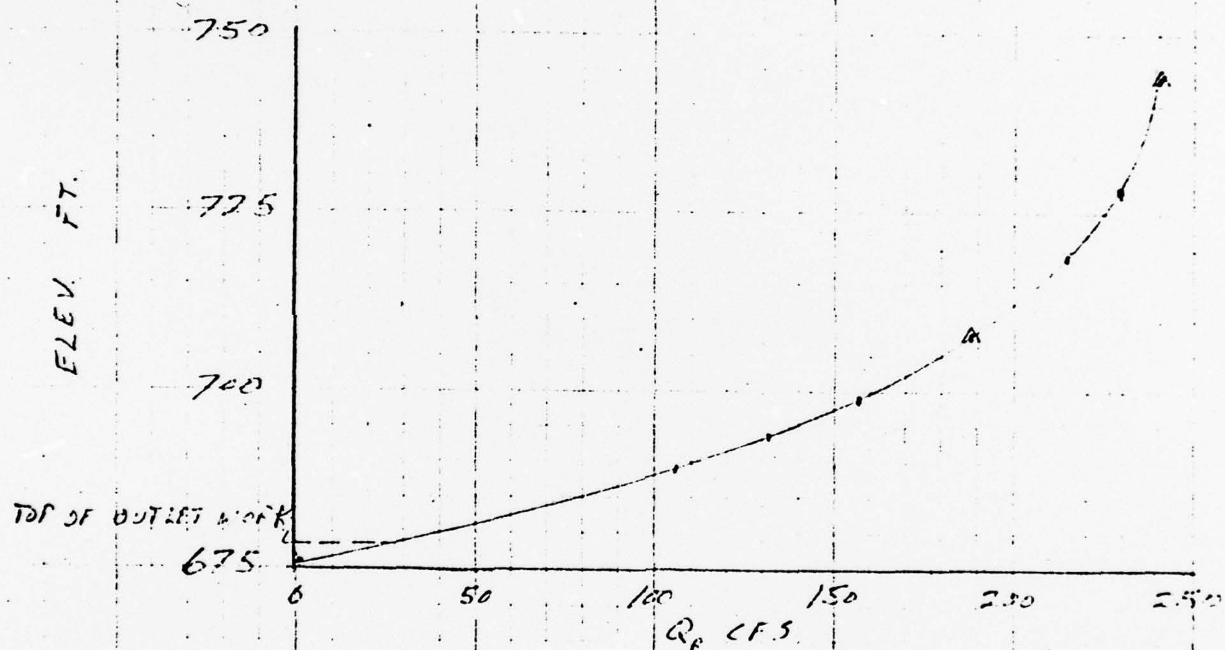
$$Q = 0.85 \times .785 \times 2.5^2 \times \sqrt{64.4\times30.72} = 185 \text{ cfs}$$

Actual discharge is between 192 and 185, say 187 cfs.

SHEET NO. ___ OF 16
JOB NO.
BY KLP DATE

STEEL BLOW OFF PIPE
FOR ELEVATIONS BELOW 733

ELEV. (FT)	Q_E
733	240
708	187
675	0



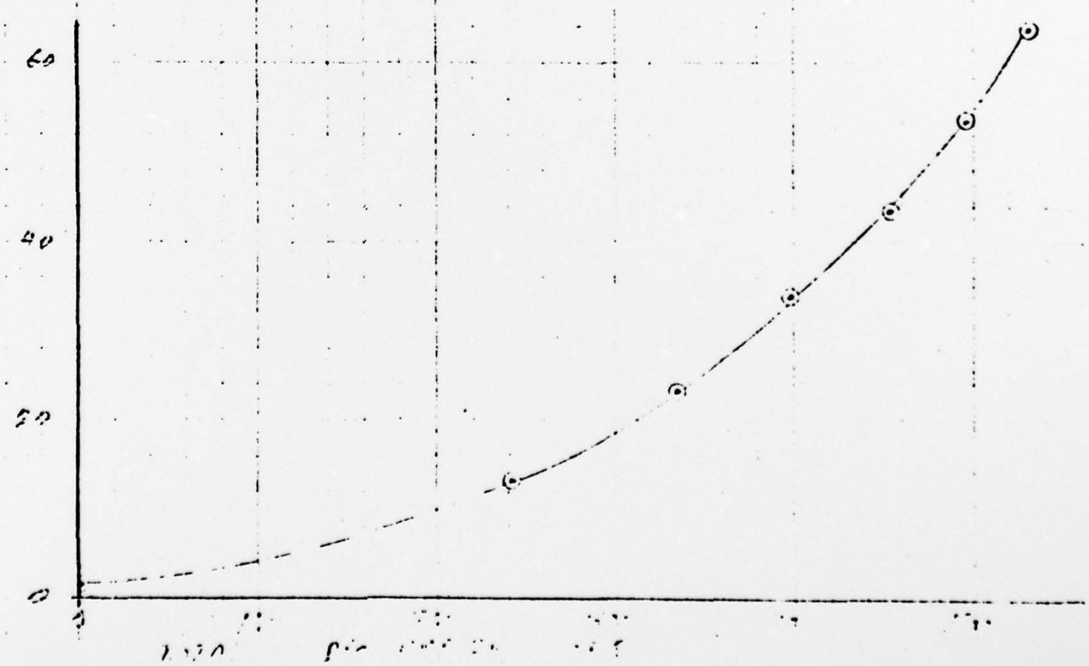
SHEET NO. 17

[illegible]BURG [illegible] JOB NO. [illegible]

[illegible] BY [illegible] DATE [illegible]

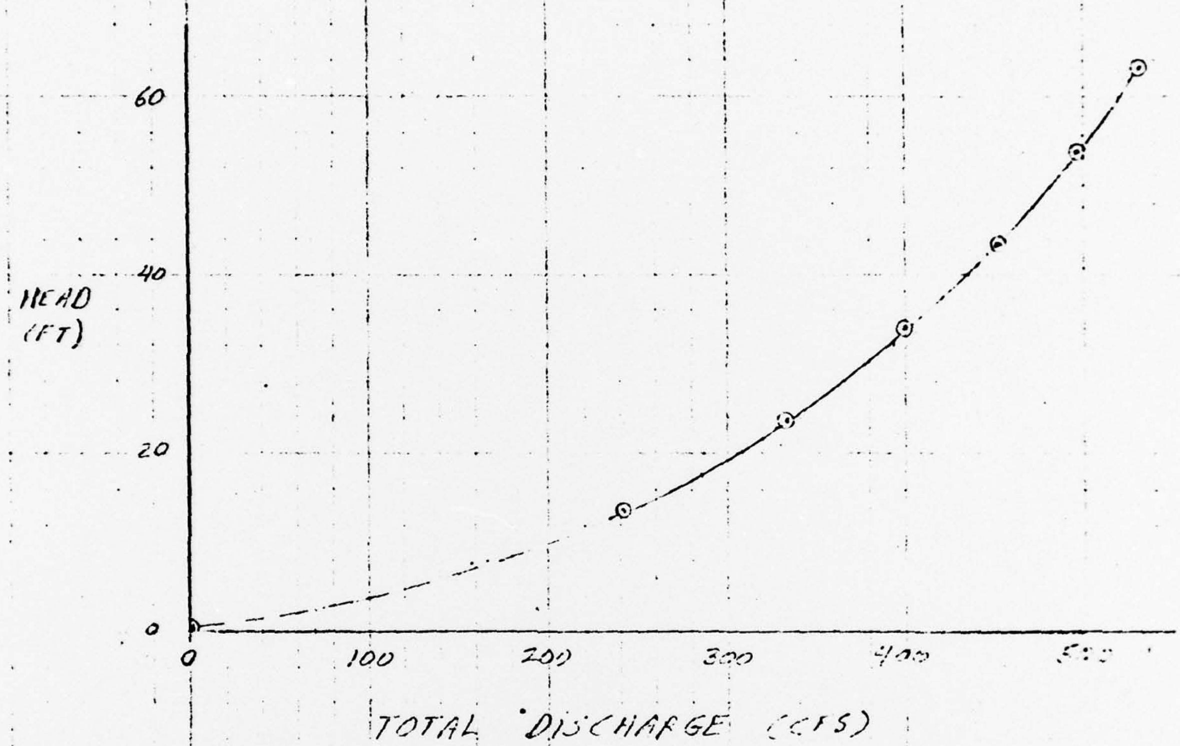
WATER SURFACE ELEVATION (FT)	H (FT)	$Q_{54''}$ $= 36.72\sqrt{H}$ (CFS)	Q_E (FROM p. 7) (CFS)	Q_{TOTAL} (CFS)
738	63.5	293	240	533
728	53.5	269	229	498
718	43.5	242	214	456
708	33.5	213	187	400
698	23.5	178	157	335
688	13.5	135	106	241
678	0	0	0	0

TOP OF OUTLET WORKS
ELEV 6[illegible].5



a) DISCHARGE VS. HEAD

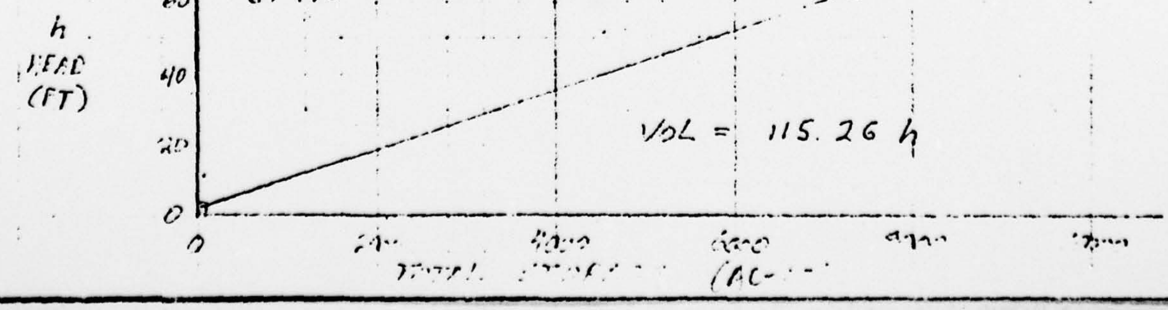
(REFER TO MRS' NOTES OF 6-15-72)



b) STORAGE VS. HEAD

ASSUME A STRAIGHT LINE RELATIONSHIP FROM NORMAL WATER SURFACE VOLUME TO ZERO VOLUME AT ZERO HEAD

ELEV	HEAD	STORAGE
738	63.5	7319 AC-FT (ASSUMED)
674.5	0	0



c) DRAINAGE AREA = 53.7 SQ. mi

INFLOW = 2 CFS/SQ. mi × 53.7 SQ. mi

= 107.4 CFS

d) WITH CONSTANT INFLOW = 107.4 CFS
INFLOW ≈ OUTFLOW AFTER 612 HOURS

(FROM COMPUTER PRINTOUT) = 25.5 DAYS

e) WITH ZERO INFLOW

RESERVOIR EVACUATION TIME = 276. HR

(FROM COMPUTER PRINTOUT) = 11.50 DAYS

[illegible]

RESERVOIR EVACUATION
WITH CONSTANT INFLOW

SHEET NO. [illegible] OF 20
JOB NO. [illegible]
BY KLE DATE 7-1[illegible]

HEAD (FT)	VOLUME (AC-FT)	TOTAL DISCHARGE (CFS) (FROM GRAPH)	INFLOW (CFS)	AVAILABLE DISCHARGE (CFS)	EVACUATION TIME (HR)
63.5					
	403.21	525.	107.4	417.6	11.68
60.0					
	576.30	510.	107.4	402.6	17.32
55.0					
	576.30	491.	107.4	383.6	18.18
50.0					
	576.30	472.	107.4	364.6	19.13
45.0					
	576.30	447.	107.4	339.6	20.53
40.0					
	576.30	420.	107.4	312.6	22.31
35.0					
	576.30	392.	107.4	284.6	24.50
30.0					
	576.30	361.	107.4	253.6	27.50
25.0					
	576.30	328.	107.4	220.6	31.61
20.0					
	576.30	287.	107.4	179.6	38.83
15.0					
	576.30	234.	107.4	126.6	55.08
10.0					
	576.30	167.	107.4	59.6	117.00
5.0					
	576.30	70.	107.4	—	—
0.0					
TOTALS	7319.	—	—	—	403.67 HR

INFLOW ≈ OUTFLOW AFTER 403.67 HR [illegible]

= 16.82 DAYS

RESERVOIR EVACUATION
WITH PIPE DRAWDOWN

JOB NO. [illegible] 21
BY MB DATE 7-18

HEAD (FT)	VOLUME (AC-FT)	TOTAL DISCHARGE (CFS) (FROM CURVE)	EVACUATION TIME (HR)
63.5			
	403.21	525.	9.29
60.0			
	576.30	510.	13.67
55.0			
	576.30	491.	14.20
50.0			
	576.30	472.	14.77
45.0			
	576.30	447.	15.60
40.0			
	576.30	420.	16.60
35.0			
	576.30	392.	17.79
30.0			
	576.30	361.	19.32
25.0			
	576.30	328.	21.26
20.0			
	576.30	287.	24.30
15.0			
	576.30	234.	29.80
10.0			
	576.30	167.	41.76
5.0			
	576.30	70.	99.62
0.0			
TOTALS	7319.	—	337.98

RESERVOIR EVACUATION TIME = 337.98 HR or (14.0) ;
= 14.0 DAYS

CHARLOTTEBURG DAM RESERVOIR DRAWDOWN STUDY (DA = 53.7 SQ. MI.)

1.0000 UNREGULATED DIVERSION CONDUIT AT ELEV 679.50 FT

MAXIMUM OPERATION LEVEL AT ELEV 738.00 FT (FROM OPERAT
MINIMUM OPERATION LEVEL AT ELEV 679.50 FT

ROUTING STARTS AT ELEV 738.00 FT, ENDS AT ELEV 679.50 FT

TIME DAY	TIME HR	AVG.INFLOW CFS	RESERVOIR EL FT	MAIN SPILLWAY DISCHARGE CFS	OVERFLOW SPILLWAY DISCHARGE CFS	Outlet DISCHARGE CFS
0	0		738.00			
		0.				
0	12		733.64	0.	0.	519.
		0.				
1	0		729.41	0.	0.	503.
		0.				
1	12		725.30	0.	0.	488.
		0.				
2	0		721.33	0.	0.	472.
		0.				
2	12		717.49	0.	0.	453.
		0.				
3	0		713.82	0.	0.	434.
		0.				
3	12		710.31	0.	0.	414.
		0.				
4	0		706.95	0.	0.	395.
		0.				
4	12		703.76	0.	0.	376.
		0.				
5	0		700.73	0.	0.	356.
		0.				
5	12		697.37	0.	0.	335.
		0.				
6	0		695.14	0.	0.	323.
		0.				
6	12		692.55	0.	0.	302.
		0.				
7	0		690.17	0.	0.	274.
		0.				
7	12		688.03	0.	0.	242.
		0.				
8	0		686.17	0.	0.	208.
		0.				
8	12		684.58	0.	0.	175.

CHARLOTTESBURG FLOOD ROUTING STUDY
****

TIME		AVG.INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
		0.				
9	0		683.26	0.	0.	145.
		0.				
9	12		682.17	0.	0.	119.
		0.				
10	0		681.28	0.	0.	97.
		0.				
10	12		680.56	0.	0.	78.
		0.				
11	0		679.97	0.	0.	63.
		0.				
11	12		679.50	0.	0.	51.

****

RESERVOIR ELEVATION WENT UNDER MINIMUM WATERSURFACE ELEVATION
AFTER 11 DAYS AND 12 HOURS

TOTAL INFLOW VOLUME 0. ACFT
TOTAL DISCHARGE VOLUME 7319. ACFT

MAXIMUM WATER SURFACE ELEVATION 738.00 FT

MAXIMUM DISCHARGE THRU DIVERSION CONDUIT 519. CFS

MAXIMUM TOTAL INFLOW 0. CFS
MAXIMUM TOTAL DISCHARGE 533. CFS

CHARLOTTEBURG DAM RESERVOIR DRAWDOWN STUDY (DA = 53.7 SQ. MI.)

1.0000 UNREGULATED DIVERSION CONDUIT AT ELEV 679.50 FT

MAXIMUM OPERATION LEVEL AT ELEV 738.00 FT (FROM OPERAT
MINIMUM OPERATION LEVEL AT ELEV 679.50 FT

ROUTING STARTS AT ELEV 738.00 FT, ENDS AT ELEV 679.50 FT

TIME DAY	HR.	AVG. INFLOW CFS	RESERVOIR EL FT	MAIN SPILLWAY DISCHARGE CFS	OVERFLOW SPILLWAY DISCHARGE CFS	Outlet DISCHARGE CFS
0	0		738.00			
		107.				
0	12		734.52	0.	0.	522.
		107.				
1	0		731.13	0.	0.	510.
		107.				
1	12		727.85	0.	0.	497.
		107.				
2	0		724.66	0.	0.	486.
		107.				
2	12		721.58	0.	0.	473.
		107.				
3	0		718.60	0.	0.	459.
		107.				
3	12		715.75	0.	0.	444.
		107.				
4	0		713.02	0.	0.	429.
		107.				
4	12		710.41	0.	0.	414.
		107.				
5	0		707.92	0.	0.	400.
		107.				
5	12		705.55	0.	0.	387.
		107.				
6	0		703.28	0.	0.	373.
		107.				
6	12		701.14	0.	0.	359.
		107.				
7	0		699.12	0.	0.	344.
		107.				
7	12		697.20	0.	0.	333.
		107.				
8	0		695.36	0.	0.	324.
		107.				
8	12		693.61	0.	0.	312.

FLOOD ROUTING STUDY

****

TIME DAY	TIME HR	AVG. INFLOW CFS	RESERVOIR EL FT	MAIN SPILLWAY DISCHARGE CFS	OVERFLOW SPILLWAY DISCHARGE CFS	Outlet DISCHARGE CFS
		107.				
9	0		691.98	0.	0.	296.
		107.				
9	12		690.49	0.	0.	278.
		107.				
10	0		689.15	0.	0.	259.
		107.				
10	12		687.97	0.	0.	240.
		107.				
11	0		686.94	0.	0.	222.
		107.				
11	12		686.05	0.	0.	206.
		107.				
12	0		685.30	0.	0.	190.
		107.				
12	12		684.66	0.	0.	177.
		107.				
13	0		684.14	0.	0.	165.
		107.				
13	12		683.70	0.	0.	155.
		107.				
14	0		683.34	0.	0.	146.
		107.				
14	12		683.04	0.	0.	139.
		107.				
15	0		682.79	0.	0.	134.
		107.				
15	12		682.59	0.	0.	129.
		107.				
16	0		682.43	0.	0.	125.
		107.				
16	12		682.29	0.	0.	122.
		107.				
17	0		682.18	0.	0.	119.
		107.				
17	12		682.09	0.	0.	117.
		107.				
18	0		682.02	0.	0.	115.
		107.				
18	12		681.96	0.	0.	113.
		107.				
19	0		681.91	0.	0.	112.
		107.				
19	12		681.87	0.	0.	111.
		107.				
20	0		681.84	0.	0.	111.

TIME		AVG.INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
20	12	107.	681.81	0.	0.	110.
21	0	107.	681.79	0.	0.	109.
21	12	107.	681.78	0.	0.	109.
22	0	107.	681.76	0.	0.	109.
22	12	107.	681.75	0.	0.	108.
23	0	107.	681.74	0.	0.	108.
23	12	107.	681.73	0.	0.	108.
24	0	107.	681.73	0.	0.	108.
24	12	107.	681.72	0.	0.	108.
25	0	107.	681.72	0.	0.	107.
25	12	107.	681.71	0.	0.	107.
26	0	107.	681.71	0.	0.	107.
26	12	107.	681.71	0.	0.	107.
27	0	107.	681.71	0.	0.	107.
27	12	107.	681.71	0.	0.	107.
28	0	107.	681.70	0.	0.	107.
28	12	107.	681.70	0.	0.	107.
29	0	107.	681.70	0.	0.	107.
29	12	107.	681.70	0.	0.	107.
30	0	107.	681.70	0.	0.	107.
30	12	107.	681.70	0.	0.	107.
31	0	107.	681.70	0.	0.	107.
1	12	107.	681.70	0.	0.	107.

TIME DAY	HR	AVG. INFLOW CFS	RESERVOIR EL FT	MAIN SPILLWAY DISCHARGE CFS	OVERFLOW SPILLWAY DISCHARGE CFS	Outlet DISCHARGE CFS
		107.				
32	0		681.70	0.	0.	107.
		107.				
32	12		681.70	0.	0.	107.
		107.				
33	0		681.70	0.	0.	107.
		107.				
33	12		681.70	0.	0.	107.
		107.				
34	0		681.70	0.	0.	107.
		107.				
34	12		681.70	0.	0.	107.
		107.				
35	0		681.70	0.	0.	107.
		107.				
35	12		681.70	0.	0.	107.
		107.				
36	0		681.70	0.	0.	107.
		107.				
36	12		681.70	0.	0.	107.
		107.				
37	0		681.70	0.	0.	107.
		107.				
37	12		681.70	0.	0.	107.
		107.				
38	0		681.70	0.	0.	107.
		107.				
38	12		681.70	0.	0.	107.
		107.				
39	0		681.70	0.	0.	107.
		107.				
39	12		681.70	0.	0.	107.
		107.				
40	0		681.70	0.	0.	107.
		107.				
40	12		681.70	0.	0.	107.
		107.				
41	0		681.70	0.	0.	107.
		107.				
41	12		681.70	0.	0.	107.
		107.				
42	0		681.70	0.	0.	107.
		107.				
42	12		681.70	0.	0.	107.
		107.				
[illegible]	0		681.70	0.	0.	107.

FLOOD ROUTING STUDY
****

TIME		AVG. INFLOW	RESERVOIR EL	MAIN SPILLWAY DISCHARGE	OVERFLOW SPILLWAY DISCHARGE	Outlet DISCHARGE
DAY	HR	CFS	FT	CFS	CFS	CFS
		107.				
43	12		681.70	0.	0.	107.
		107.				
44	0		681.70	0.	0.	107.
		107.				
44	12		681.70	0.	0.	107.
		107.				
45	0		681.70	0.	0.	107.
		107.				
45	12		681.70	0.	0.	107.
		107.				
46	0		681.70	0.	0.	107.
		107.				
46	12		681.70	0.	0.	107.
		107.				
47	0		681.70	0.	0.	107.
		107.				
47	12		681.70	0.	0.	107.
		107.				
48	0		681.70	0.	0.	107.
		107.				
48	12		681.70	0.	0.	107.
		107.				
49	0		681.70	0.	0.	107.
		107.				
49	12		681.70	0.	0.	107.
		107.				
50	0		681.70	0.	0.	107.

TOTAL INFLOW VOLUME 11094. ACFT
TOTAL DISCHARGE VOLUME 18137. ACFT

MAXIMUM WATER SURFACE ELEVATION 738.00 FT

MAXIMUM DISCHARGE THRU DIVERSION CONDUIT 522. CFS

MAXIMUM TOTAL INFLOW 107. CFS
MAXIMUM TOTAL DISCHARGE 533. CFS

CHARLOTTEBURG DAM — SHEET NO. 3 OF ___

RESERVOIR EVACUATION — JOB NO. 1209-001-1

WITH CONSTANT INFLOW — BY KLB DATE 7-18-78

HEAD (FT)	VOLUME (AC-FT)	TOTAL DISCHARGE (CFS) (FROM GRAPH)	INFLOW (CFS)	AVAILABLE DISCHARGE (CFS)	EVACUATION TIME (HR)
63.5					
	403.21	525.	107.4	417.6	11.68
60.0					
	576.30	510.	107.4	402.6	17.32
55.0					
	576.30	491.	107.4	383.6	18.18
50.0					
	576.30	472.	107.4	364.6	19.13
45.0					
	576.30	447.	107.4	339.6	20.53
40.0					
	576.30	420.	107.4	312.6	22.31
35.0					
	576.30	392.	107.4	284.6	24.50
30.0					
	576.30	361.	107.4	253.6	27.50
25.0					
	576.30	328.	107.4	220.6	31.61
20.0					
	576.30	287.	107.4	179.6	38.83
15.0					
	576.30	234.	107.4	126.6	55.08
10.0					
	576.30	167.	107.4	59.6	117.00
5.0					
	576.30	70.	107.4	—	—
0.0					
TOTALS	7319.	—	—	—	403.67 HR

INFLOW ≈ OUTFLOW AFTER 403.67 HR or 16.82 Days

= 16.82 DAYS

CHARLOTTSBURG DAM SHEET NO. 4 OF 30

RESERVOIR EVACUATION JOB NO. 1209-001-1

WITH ZERO INFLOW BY KLB DATE 7-18-78

HEAD (FT)	VOLUME (AC-FT)	TOTAL DISCHARGE (CFS) (OPEN GATE)	EVACUATION TIME (HR)
63.5			
	403.21	525.	9.29
60.0			
	576.30	510.	13.67
55.0			
	576.30	491.	14.20
50.0			
	576.30	472.	14.77
45.0			
	576.30	447.	15.60
40.0			
	576.30	420.	16.60
35.0			
	576.30	392.	17.79
30.0			
	576.30	361.	19.32
25.0			
	576.30	328.	21.26
20.0			
	576.30	287.	24.30
15.0			
	576.30	234.	29.80
10.0			
	576.30	167.	41.76
5.0			
	576.30	70.	99.62
0.0			
TOTALS	7319.	--	337.98

RESERVOIR EVACUATION TIME = 337.98 HR or 14.07 Days

= 14.08 DAYS